Monograph 3 in Studies of Southern Resources made by the Institute for Research in Social Science, University of North Carolina, for the Southern Association of Science and Industry.

RESEARCH IN SOUTHERN REGIONAL DEVELOPMENT

by

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FOREWORD BY
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FOREWORD

THE excellent study of "Research In Southern Regional Development" by Dr. Edith Webb Williams is most timely and should be of profound interest to southern businessmen and scientists. Nature blessed the South in many ways. Excellent climate, water, natural resources, raw materials and productive soil have been our heritage. But for decades we were committed to an agrarian economy, content to live largely on the bounty of our natural resources and agriculture. Much of our raw materials have been sent to other regions, fashioned into finished products and then sent back for purchase by southern consumers. Such economy resulted in but little profit for people of the South.

No section of the nation has more on which to build and more reason to build than does the South.

The progress of mankind marches step by step with a record of social and economic improvements brought about through research.

"During the last half century in the United States," said the distinguished Dr. Wilson Compton at Chapel Hill several years ago, "more than one half of our new material wealth has come from new ideas which were not known fifty years ago or at least were not applied to the production of things. But for the South as a whole the proportion has been less than one tenth. Rich in diversified natural resources, the South has not been proportionally rich in ideas or in opportunities."

We were told by this distinguished scientist in his objective review of our region that

> The South has been engaged busily in the exploitation of its soils, forests and mines;
>
> Largely the South is still living off its resources, not off its ideas;
>
> We must learn to depend less on resources which have been made for us and more on ideas, which we must make and apply for ourselves,—the heart of the "scientific spirit."

Such forceful thoughts were and continue to be a severe indictment of a region of great and resourceful people.

Yet, as Dr. Williams again points out, there is a hopeful trend; a growing awareness of research and what it should mean to the Southern Region. We are beginning, just beginning, to join boldly in the march of science. There is much to be done.

These social and economic studies from the scholars of Chapel Hill give cause again for expression of gratitude to the distinguished Howard W. Odum for his *Southern Regions* published in 1936.

As pointed out by both Dr. Odum and Dr. Williams, the Southeast is rich in all resources, but does not afford adequate facilities—science, invention, technology—for the utilization of its physical and human wealth.

Through this excellent study of Dr. Williams, we have the record in respect of research brought down to a recent date.

Certainly we who have been active in the work of the Southern Research Institute recognize the fundamental truths stressed by Dr. Williams, that—

> "The South needs far more research than it now possesses;"

and that

> "The rest of the country will not wait for the South to catch up."

The importance of this analysis of Dr. Williams lies not only in its factual study, but in stimulating southern people to continue the present trend with increasing determination.

THOS. W. MARTIN.

Birmingham, Alabama
September 8, 1948.

PREFACE

THIS series of Studies of Southern Resources, undertaken by the Institute for Research in Social Science of the University of North Carolina for the Southern Association of Science and Industry, turns now in Monograph 3 to consideration of a factor of strategic importance in regional development—*research.*

The study rests on the assumption that in an age of increasing mechanization and scientific application, with the resulting complexity of economic and social organization, objective investigation on all fronts is essential for survival. Specific needs for research have been pointed out in the two preceding monographs: *Forestry in the South* by C. F. Korstian and Lee M. James, and *Southern Resources for Industrial Development*, by Harriet L. Herring. The present analysis goes into the inadequacy of the research facilities and research personnel of the region as compared with other parts of the country.

Research is considered as a basic resource of the South whether conducted by private business and industry, by colleges and universities, or by governmental agencies. The scope covered by the author includes fundamental and applied research in the physical, biological, and social sciences. A challenge is thrown out for greater development and coordination of research in the South looking toward a region which can more adequately play its role in the regional balance of America.

The author, Edith Webb Williams, is a native of North Carolina. She served as research assistant in the Southern Regional Study under the direction of Howard W. Odum at the University of North Carolina and completed the Ph. D. degree in Sociology at Cornell University. *Research in Southern Regional Development* was a special assignment while she was Research Associate in the Institute for Research in Social Science.

Katharine Jocher as Technical Editor for this series of monographs is in charge of preparation of the manuscripts for publication.

GORDON W. BLACKWELL
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President
Southern Association of Science and Industry.

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SUMMARY STATEMENT

ASSUMPTIONS

1. A region must have human, technological, and institutional resources if it is to translate its natural resources into capital wealth and thus raise the economic level of its people and enable them to reach a higher level of cultural development. Scientific research is one of the more important technological resources, and it is therefore essential to a regional program of economic development and social improvement.

2. While research findings are not confined by geographical boundaries, a region must have research resources within its borders to get the maximum benefits from the application of science to the satisfaction of human needs.

3. Understanding of the existing situation is preliminary to an effective program of action.

FINDINGS

4. The South has relatively little industrial research. Its dominant industries are ones in which research has not been extensively used. Southern industry's present lack of technical personnel hinders rapid and continuing improvement of industrial processes and development of new products. The great increase in industrial research in recent years has come through enlargement of existing laboratories in the areas where they were first established and where institutions engaged in fundamental inquiries and scientific training are located, with the result that there has been increasing geographical concentration and centralization of control. The highly successful use of research by a few southern industrial concerns shows that it is practical and profitable to develop and use this technological resource in the South.

5. The research facilities of southern colleges and universities are inadequate to meet the needs of the region for fundamental research, for trained scientific workers, and for the development of means to make research findings intelligible and practically

useful to those who have need of them. With great university research centers already established in other parts of the country it is difficult to draw superior teachers and students to institutions where equipment, teaching staffs, libraries, and fellowships are inferior, and where financial support is not available to build up these research facilities. Consequently, southern industry and government agencies generally do not have the advantage of cooperative research and consultative relations with first-class scientific men, and southern students must usually go out of their region to secure the highest level of training. Many of them do not return, and the South thus loses its top layer of potential scientific talent. Present southern leadership can lay the foundation for regional development, but the actual work in all its details will have to be done by those who have not yet reached maturity. Their training is crucial.

6. The South receives great benefit from the research program of the Federal Government. State and city government agencies in the southern regions also support research and use research to improve the operations of their various departments. Limitations upon governmental research make it unlikely, however, that deficiencies in other fields can be made up by governmental action. To get the greatest benefit from governmental research there must be technical personnel in other institutions to follow new developments and apply findings to immediate problems. Furthermore, Federal Government research which is delegated by contract to other agencies necessarily goes where there is the best equipment and personnel. Regions deficient in research facilities do not share in such research, as was amply demonstrated during the war. Even the proposed federal scholarships for prospective research personnel will be of relatively little benefit to the South unless better training centers are provided.

7. All types of research are under-developed in the South—fundamental, background, and applied research in both natural and social science fields. In the nation as a whole applied research and natural science research have been more amply supported and highly developed than fundamental research and social science research. The total amount in the South is so small that less imbalance among the types is evident.

8. The South's over-all lack of trained scientific personnel is a stumbling block to every move to increase research. The problem is one which reaches back into the secondary schools where science instruction is often not adequate to discover latent talent or to inspire students to begin scientific careers, and perhaps back of the schools to a society which has not put science high enough in its scale of values to promote training in science or opportunities to use scientific skill. If one need of the southern regions can be given priority in importance and urgency it is that of improving opportunities for young people to realize their capacities through the development of scientific skills which can then be put to use in widespread development of the other resources of the South.

9. There is growing awareness among industrial, political, and educational leaders in the South of the deficiencies in research and of the necessity to correct them. Efforts are being made to increase research in all fields.

CONCLUSIONS

10. The research needs of the South are so great that there is room for work by every type of agency and organization. Since research can be used advantageously in all aspects of economic and social life, the development of research facilities and personnel provides a common goal for separate and combined effort with a minimum of conflict of interest.

11. The present distribution of research facilities in the nation puts extraordinary difficulties in the way of development of adequate research in the South. Ingenious means must be found to overcome these difficulties.

12. The complex interdependence of the various aspects of research requires a balanced approach. Additional laboratories cannot be manned unless additional training facilities are provided. Profitable applied research depends upon support of fundamental studies. Widespread support and use of research will not come unless all the people come to appreciate what science can do to help them achieve the ends they consider to be good.

13. The under-development of research in the South makes possible a more balanced growth than has taken place elsewhere.

For this reason the present situation may be regarded as an opportunity to profit from the experience of others. Regional needs will not be met by physics and chemistry alone. Indeed, difficulties may well be increased through further natural science research if there is no growth in knowledge concerning human relations. With the opportunity to develop new patterns of research organization and emphasis, the South might well put social science investigations ahead of others. In the social sciences it can make a valuable contribution to mankind while increasing the efficiency with which natural science findings are used to satisfy the needs of its own people.

14. Cooperation among research agencies offers one way to get the maximum benefits from existing facilities and from money spent for expansion. Present cooperative arrangements offer suggestions for further developments. Workers in related fields can learn from each other's findings. Agencies interested in a common goal can combine efforts to avoid duplication and increase efficient use of equipment and personnel. Small business units and industrial associations can build joint research programs. Commercial and university research agencies can be used more widely, thus increasing facilities economically. Cooperative research should bring closer integration between the search for knowledge and the democratically agreed upon goals of the community at large, thus increasing the social responsibility of the scientific worker.

15. Cooperation and coordination can be assisted by spreading knowledge of local, state, and regional research agencies and programs. Coordination must be achieved through voluntary means if it is not to control and thereby stifle; consequently the role of a coordinating organization must be carefully conceived and executed. Of primary importance is a clearing house service where information about research activities can be secured and active encouragement given to mutual assistance through cooperation. An organization composed of scientists, businessmen, and public officials, tied together by a common interest in balanced regional development, is needed to provide this service and to serve as a rallying point for the promotion of support of all types of research.

I

RESEARCH AS A RESOURCE

SOMETHING MUST BE ADDED

THE southerner may properly be thankful for the climate, the raw materials, and the scenic splendors of his region, but he should take pride only in what he has actually done with his heritage. Resources which remain only potential contributors to human comfort and development are no more worthy of praise or pride on the part of men than a talent buried in the earth. Instances in which great natural wealth has remained undeveloped, even unknown, are not hard to find, both in history and in a world-wide comparison of peoples and lands today; they bear witness to the fact that a region's well-being is not assured by mere possession of natural resources.

Self-analysis of the southern regions as a basis for self-advancement must, therefore, pay full attention to human, institutional, and technological resources, the tools with which natural resources are transformed into useful wealth. The goal is to provide more complete satisfaction of the wants of people and wider opportunities for their development through wise use of all resources. If we wish to give away or sell cheaply what we have, it is enough to write glowing advertisements begging people from other regions to develop our natural resources and thus to admit our own inability or unwillingness to do the job. If we would do something for ourselves, we must find out what we have with which to start, the natural resources and also the tools and knowledge and skills embodied both in individuals and in organizations. Given the will, we shall then find the ways to use what we have to strengthen the southern region and increase its contribution to the nation of which it is an integral part.

Because of the direct and important relationship of scientific research to a program for industrial and social development of the South through wise use of natural resources, an analysis of the research resources of the region is of special interest. The knowledge we now possess of the region's basic materials, human and natural, and the derived resources, capital, technological, and institutional, has come through research. But there are still many

gaps in our information, and the history of scientific advance emphasizes the necessity for continuous study. No development program in the modern world can rely on what is already known. It is therefore essential to give attention to the facilities and personnel available both for the application of existing scientific knowledge and skill and invention to basic materials and also for further study. If a successful practical program is to grow out of the present interest of industrialists and scientists in southern development, it must include an increase in the amount and use of research in the South; this, in turn, can be planned wisely only if we know all we can discover about the foundation on which the increase must be built.

THERE IS RESEARCH—AND RESEARCH

In Florida an industrial corporation is conducting research on the recovery and refining of oils, terpenes, and resins naturally occurring in pine wood; in Virginia the State Geological Survey is making a study of the geology and water resources of the York-James peninsula; in Texas the Institute of Technology and Plant Industry is conducting investigations in plant chemistry. These are three different types of research projects.

Precise and exclusive definitions of types of research are difficult to formulate, but certain distinctions are useful in interpreting the over-all situation in research. Their relation to the control and support and interrelations of the different agencies conducting research make them necessary background for planning. The traditional distinction between fundamental, or basic, research and practical, or applied, research is generally accepted; there may also be distinguished what has been called "background" research.

The research conducted by private industry is almost entirely of the applied type. It is practical in an immediate sense. The worker in the industrial laboratory puts scientific knowledge to use for his employer. His primary aim is not to increase knowledge but to increase profits through the application of existing knowledge in a specific situation. Similarly the government research worker who is using scientific knowledge to find the answer to a specific problem, whether it be control of the

Japanese beetle or improvement of weather prediction, is conducting applied research.

Fundamental research is concerned with the more general goal of increasing scientific knowledge. It is not guided by immediate and specific needs but by the desire to learn more about the relationships and processes of phenomena, as in a general investigation of the characteristics and properties of metals. Research of this type frequently takes long periods of time and seems to have no utility. A few large corporations which have developed extensive research programs do carry on fundamental investigations, but these are exceptions. Governmental agencies also carry on some basic research, but the amount is relatively small in comparison with their applied research activities. For basic research the country depends chiefly on universities and on institutes supported by private philanthropy. Yet the industrial and the governmental research workers are directly dependent upon basic findings for the knowledge which they put to use for immediate purposes. If fundamental research were discontinued, the accomplishments of the more practical scientists would soon be reduced, and finally would end.

Background research falls somewhere between the other two types in the immediacy of its ends. It consists of the collection and classification of basic data and the establishment of standards. This provides material necessary to the other types of research; but the activity offers great difficulties for the private investigator or organization and, as a consequence, is almost entirely confined to government agencies. There is little question about the public interest in having background research done and the special fitness of governmental agencies to do the job. Background research is illustrated by topographic and geologic maps, the collection of meteorological data, the determination of physical and chemical constants, and the establishment of standards for hormones and drugs. The United States Geological Survey and the State surveys, the Coast and Geodetic Survey, the Weather Bureau, and the Bureau of Standards are devoted to background research.

These distinctions have not been applied widely to social science research. Where applied social science research is being used, as in consumer preference studies or personnel research, it

is often not given this name. However, the same general distinctions can be made in this field without any greater difficulty than is met in the natural sciences. The same differences exist in the immediacy and specificity of the ends prompting the study.

All the types of research are interrelated and all are necessary to assure the application of science to the development and wise use of the resources of a region. Although each tends to be the specialty of one of the three organizational divisions of the research world, universities and private institutes, government, and industry, there is much overlapping and many institutions carry on all types. Since it is easier to secure financial support for the other types, constant effort is needed to maintain fundamental research at a level which will provide the necessary basis for continuing development of applications. A special case can be made for fundamental research in the social sciences to enable our society to cope with its many problems of organization and control, aggravated as they are by the accelerating achievements of the natural scientists.

INVESTIGATING RESEARCH RESOURCES

A complete account of a region's resources for research should include a detailed and accurate description and evaluation of its research personnel, of the facilities for training additional workers, of laboratory and other equipment, of library materials, of the agencies organized to conduct research, and of actual and potential financial support for research. Research agencies with nation-wide programs should be included along with regional and local ones.

There are many reasons why this ideal presentation is not possible. Exact definitions of research personnel and activities are difficult to make and there is no strict line separating these activities from all others. The research staff of an industrial company may combine research with production control and product testing. In many government agencies research is combined with record keeping or the collection of material from other agencies and fluctuates with appropriations and the pressure of administrative interest and needs. College and university teachers often conduct investigations outside any formal research programs.

Furthermore, the currently high value given to science and research leads many to magnify the research aspects of their work; while the popular use and misuse of these terms lead the trained scientist to be more conservative in his definition of what constitutes research.

Classification of actual behavior, even though it is clearly scientific research, presents many problems. One business company may conduct research in silviculture, in paper chemistry, and in production engineering. The projects of an agricultural experiment station may vary from a study of the internal parasites of swine to an inquiry into the church activities of rural youth. On the other hand, agricultural research is conducted by government agencies, by private business companies, by private research institutes, by trade associations, and by individuals. The varied combinations of subject matter, type of investigation, administrative organization, and purpose do not lend themselves to neat categories and summarization. A complete survey in detail would be prohibitive in cost.

An additional obstacle to a complete account is the understandable reluctance of many industrial concerns to reveal the details of their research activities. The secrecy surrounding investigations was accentuated and spread to all types of organizations by war conditions, since a large proportion of all research was related to military production and needs.

Even if the information were available for a complete account of research resources, the presentation would be out of date before it could be put into print. Before the war the trend was toward industrialization and a consequent growth of industrial research in the South. Public agencies were also beginning research programs. Constant changes were taking place, most of them in the direction of increasing research. In many cases the effect of the war was to halt the trend, even to bring all research to a standstill. Trained personnel was taken by the Army and Navy and by governmental agencies and war industries. In other cases where industries were engaged in essential production for the Armed Services the development of research was accelerated. The indications are that the amount and pace of change are no less in the postwar period.

A BROAD VIEW OF RESEARCH RESOURCES

In a search for resources the first aim is to include everything which will contribute to the purpose in mind. The South has need of all sorts of investigations and studies and compilations of material—exploratory and definitive; social science and natural science; statistical, descriptive, and experimental; fundamental, background, and applied. Research interest and research activities which do not meet the requirements of the careful laboratory technician may nevertheless play an important part in providing needed information. They are resources which may be used in a program of regional development, particularly if the interest and the energy can be coordinated with the efforts of the more exact scientists and perhaps guided into more productive channels.

This survey of research resources is then first of all broadly inclusive. The aim has been to include all activities which might be classified as research under the broadest possible interpretation. Any serious investigation or study made to increase knowledge in any field by methods in keeping with the spirit of scientific inquiry has been considered to be research. This kind of loose definition will be unsatisfactory to many and it has serious disadvantages, but it seems the only appropriate one for an exploratory survey to discover the research resources which the southern region has available for use.

The data are presented under broad groupings of the organizations conducting research. The arrangement was partly dictated by the way in which information was secured and partly by the desire to include the organizational framework within which the various types of research are conducted as a necessary basis for regional plans to increase the use of research. Only agencies located in the South have been included. These are the ones most significant for planning toward regional development and the ones for which least information is available from other sources.

Little attempt has been made to evaluate the quality of the work done by the various research agencies. Evaluation is needed and should come later with more exhaustive studies of particular aspects of the general account presented now. Here the broad outlines of the existing situation are summarized on the basis of available material, and some of the needs and possibilities for

future development are indicated. There are many specific problems needing further and more detailed analysis.

SOUTHERN RESEARCH AND NATIONAL RESEARCH

Compared with other parts of the country, the South has few research resources. Such a comparison is relevant because natural resources have been used more effectively in other parts of the country to satisfy the wants of the people. The lack of a comparable development of scientific knowledge and techniques in the South is clearly related to its lower level of living. The fact that other regions have made better use of their natural resources is an index both of past southern failures and present southern opportunities. Furthermore, the existing distribution of research facilities will influence every move to increase research in the South. Hence the account of southern research resources must be placed within the broad framework of national research resources.

II

THE RESEARCH OF PRIVATE BUSINESS AND INDUSTRIAL CONCERNS

INDUSTRIAL RESEARCH IN THE NATION

THE National Research Council has published eight editions of the directory, *Industrial Research Laboratories of the United States*, the first in 1920 and the last in 1946. Although the directories themselves show the remarkable growth of industrial research during the period covered, further analyses of the data provide a more detailed account. A study of the material for the first six editions, 1920 through 1938, is included in *Industrial Research and Changing Technology*, published by the Work Projects Administration in 1940. In connection with the seventh edition (1940) the National Research Council made an extensive study of industrial research in the United States for the National Resources Planning Board, which was published as volume two of the series, *Research—A National Resource*. These sources make it possible to examine in some detail the industrial research resources of the South in relation to those of the whole nation for the two decades preceding the recent war.

In the country as a whole the use of research by industry has grown prodigiously since 1920. This is true even when the better coverage of the more recent surveys is taken into account. The number of concerns reporting has grown from less than 300 in 1920 to 2,443 in 1946. In 1946 the laboratories had almost 90,000 persons engaged in technical research and related activities. While industrial research was subordinated to government research during the war and actually decreased in amount, it began rapid expansion as soon as hostilities ceased. In the recent report by the President's Scientific Research Board, *Science and Public Policy*, it is estimated that industry's expenditures for research and development in the physical and biological sciences in 1947 were 450 million dollars. The President's Advisory Commission on Universal Training arrived at a much larger figure, 750 million dollars, as its estimate of industry's expenditures for scientific research and development in 1947. These figures can be set against the 300 million dollar estimate of the National Research Council made in 1940.

SOME INDUSTRIES USE RESEARCH MORE THAN OTHERS

The amount of industrial research varies greatly among the different industries.

> The chemical and allied products industries employed the largest number of research workers in 1938. Industries next in importance were petroleum; electrical communications; electrical machinery, apparatus, and supplies; other machinery industries; and rubber products. Testing, consulting, and foundation laboratories also ranked high, employing nearly 2,700 persons in 1938. In that year more than half of all those working in industrial research laboratories in the United States were employed by the chemical, petroleum, and electrical industries (including communications, utilities, radio, and the manufacture of electrical machinery, apparatus, and supplies).[1]

On the other hand, textiles and their products reported less than one percent of the industrial research workers in 1938 and forest products an even smaller number. Other industries which ranked low in percentage of the total research workers were leather and its manufactures, transportation equipment other than motor vehicles, and paper and allied products. The industry showing the most growth in research personnel between 1927 and 1938 was petroleum and its manufactures. Others which grew rapidly were the radio and the food industries. The same general situation with regard to the distribution of research personnel prevailed in 1940. Chemicals and petroleum were still ahead of other industries in the number of research workers employed, and the same industry groups were at the bottom of the list.

The industries which provided the larger percentages of the total research workers in this period also had the larger numbers of research workers in relation to the wage earners employed in the industry, chemicals leading the list, followed by radio apparatus and phonographs, petroleum, and rubber. Textiles and their products had the smallest number of research workers per 10,000 wage earners in the industry. If estimated research expenditures for the same period are expressed as a percentage of the dollar value of the products of different industries, radio and electrical communications led the list, rubber was on a par with chemicals,

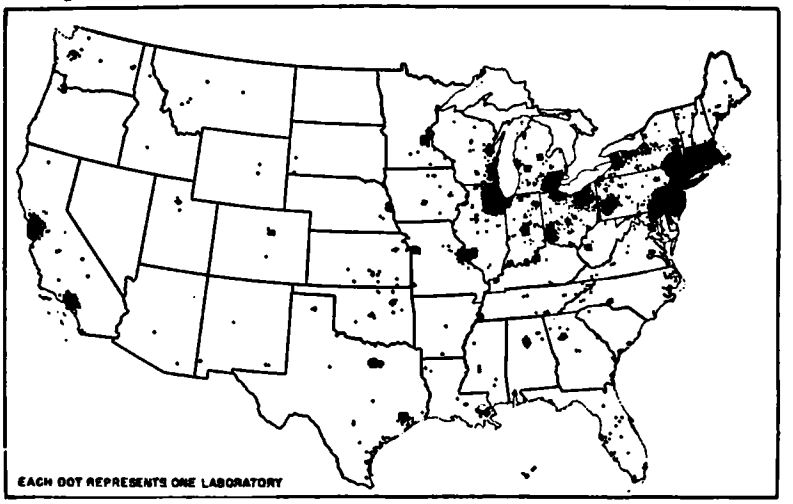
[1] George Perazich and Philip M. Field, *Industrial Research and Changing Technology* (Philadelphia: Work Projects Administration, National Research Project, Report M-4, January, 1940), p. 1

and stone, clay and glass products were almost as "research-minded" as petroleum.

INDUSTRIAL RESEARCH IS CONCENTRATED

Industrial research in the United States is concentrated to an extreme degree both in geographical location and in control. Most of the laboratories are in six states, which accounted in 1927 and in 1938 for over 70 percent of all personnel. Figure 1, based on 1940 data, shows this concentration clearly. The distribution of laboratories is obviously influenced by the location of the industries

Figure 1. GEOGRAPHICAL DISTRIBUTION OF INDUSTRIAL RESEARCH LABORATORIES, 1940



Source: National Resources, Planning Board, *Research—A National Resource, II. Industrial Research*, Figure 47, p. 177.

in which research has been most highly developed. New Jersey, New York, and Delaware have research in chemicals, Michigan research related to automobiles, Illinois that connected with agricultural implements, Ohio and New Jersey research in rubber, Pennsylvania, New Jersey, Indiana, and California petroleum research, and so on. The industries found in the South, with the exception of petroleum, are not characterized by research.

The centralization of control in industrial research is just as striking as the geographical concentration and the grouping in

specific industries. In 1938, 13 companies, less than one percent of all those reporting to the National Research Council, employed one-third of the research workers reported. These 13 companies employed as many workers as the 1,583 companies with the smallest research staffs.

> Most of the larger industrial laboratories (those employing more than 50 persons) are maintained by the electrical, chemical, petroleum, rubber, and automobile industries. Many concerns in these industries employ more than 500 research workers, and several have laboratory staffs of more than 1,000 persons.
>
> When the growth of research employment was analyzed in terms of the size of staffs, it was found that the number of enterprises with more than 50 research employees increased from 44 in 1927 to 120 in 1938. The total personnel of these large laboratories has increased from 11,200 in 1927 to about 28,700 in 1938. Moreover, the proportion of workers employed in large laboratories has increased during this period.
>
> In nine leading industries one-fourth of those companies which operated laboratories employed between 55 and 90 percent of the research workers in the respective industries.[2]

The 1940 distribution of research units and personnel was analyzed according to the "financial size" of the corporations using research. The findings are consistent with other data on concentration.

> The small contribution to total research employment made by the small and middle-sized corporate units is immediately apparent. Very evidently the bulk of industrial research contributions are being supported by a rather limited number of large corporations. The actual research achievements as well as the latent possibilities of the large number of smaller corporations should by no means be ignored, but the total bulk of their research effort is, at present, rather small.[3]

It should be noted here that the possession of a laboratory and specific research personnel is not an exact measure of the use of scientific research by a concern. Cooperation in research may exist between companies, and this may not be indicated in statistical summaries. For instance, small companies are often provided

[2] *Ibid.*, pp. 42 and 46.
[3] National Resources Planning Board, *Research—A National Resource, II. Industrial Research* (Washington: Government Printing Office, 1941), p. 182.

with certain research help by their suppliers of equipment or raw materials.

The social and economic consequences of this extreme degree of concentration are difficult to measure, but there can be no question that they are great.

> In view of the fundamental role that research has been assuming in the development and use of technology, concentration of research is significant. It means that a relatively small number of enterprises have been in a position to make scientific advance serve their special purposes. This is especially important in view of the fact that the nature of large-scale industrial research imposes certain restrictions both on the fields of inquiry and on the use of findings. Not only do the research problems investigated tend to become those peculiar to large-scale operations, thus widening their technical and economic advantages over smaller enterprises that are without research facilities and cannot keep pace with new scientific developments, but the information obtained becomes available chiefly to the operators of large laboratories.
>
> This picture is in sharp contrast to that of several decades ago, when individual inventors and technicians played an important role in the development of advanced technology and improved machinery needed for the country's growing industries.[4]

SOCIAL SCIENCE RESEARCH IN INDUSTRY

Because of the common tendency to identify the term research with natural science laboratory research, it is easy to overlook the large quantity of non-laboratory research which is conducted by business concerns. Often they themselves do not classify this work as research nor consider it as a separate unit in their organizations. Every company which collects and analyzes data for use in planning future operations is conducting research of a sort, and recognition that it belongs in the same class of activity as chemical or physical research depends upon its extent, the administrative organization, and the technical skill of the personnel conducting it. Actually social science study as a base for the projection of plans has been used more extensively and has reached a higher development in private business than in any other division of our national life.

[4] Perazich and Field, *op. cit.*, pp. 49-50.

There have been no surveys of this kind of research comparable to the material on industrial research compiled by the National Research Council. The third volume of the National Resources Planning Board's study of research as a national resource is devoted to business research, but the authors found it impossible to secure a summary of the amount of such research or of the number of firms conducting it. Some material was collected and on the basis of it a qualitative description presented of ". . . varied activities carried on in business which provide, through increased knowledge of economic, psychological and cultural facts, and principles, a better utilization of the human and material resources of the nation with which business is engaged." The account includes a discussion of various methods used by business concerns in organizing and conducting this research.

Social Science Research is Expanding

The earlier use of non-laboratory research in industry consisted entirely of so-called business and economic research, but recent developments have broadened the field and justify the more general classification of social science research in industry.

> There can be no question that many types of business research, other than natural science research, have the highest importance for business, for systematic and social analysis, and for national productivity. In many fields notable technical results are being obtained by highly competent technicians, as in the field of personnel, in scientific management, in operational analysis, in administrative organization and processes, in accounting and cost accounting, in analysis of vital statistics, in industrial relations, marketing, and with many other types of social data.[5]

The National Resources Planning Board study of business research reports economics as the chief interest of social science research workers in the business concerns examined, with marketing as the most studied subdivision of economics. The most rapidly developing field seems to be that of personnel and industrial relations research. The newest field in which interest has been shown is ". . . the broad field of public relations, ranging from a study of

[5] National Resources Planning Board, *Research—A National Resource, III. Business Research* (Washington: Government Printing Office, 1941), Introduction, p. x.

attitudes of the general public, as distinct from consumer interest, to government-business relationships, particularly the problems of local administrative powers and jurisdiction."

The wide extent and varied organizational forms of social science research in private industry are also shown in the returns secured in a study by the National Industrial Conference Board, published in 1940. The sampling method is not described but the aim is stated as an attempt to discover how economic and statistical research is organized in a cross section of industrial concerns. Seventy-five percent of the 515 companies returning questionnaires reported some economic or statistical research. Some of the 25 percent reporting no such research indicated that they made inquiries in these fields, without calling them research.[6]

Economic and statistical studies are also made by trade associations and other cooperating groups of businessmen. These vary from brief statistical summaries, compiling data on operations from member companies, to elaborate studies by large technical staffs. The National Resources Planning Board study considers the research standards of trade associations, as a group, to be low, but recognizes that the economic research activities of a few are of exceptional merit. The National Industrial Conference Board is an example of what can be done through cooperative research. Supported by varied types of industrial concerns, it is an agency devoted entirely to research, making both special studies for member firms and broad general studies. Many advertising agencies conduct marketing research for their clients, but the quality of the work done is highly variable.

More Social Science Research Needed

The value of research in the most highly developed economic field, marketing, has been recognized by the United States Department of Commerce through its regular publication, *Marketing Research Sources*, but there has been little else in the way of coordination in this field. It is relatively new, and, although the general type of research is widespread, there has been no standardization of activities, personnel practices, or administrative organization. In 1938, Frank R. Coutant, who was directing research for

[6] Clyde L. Rogers and Jarvis M. Thayer, Jr., "Economic and Statistical Research in Private Enterprise," *The Conference Board Economic Record*, II (March 5, 1940), 61-66.

an advertising agency, estimated that the use of market research had increased 50 percent in the preceding three years. His estimate of expenditures for marketing research was $4,500,000 a year, a small amount when compared with the figures for industrial research.[7] The same article states that only a handful of the largest companies conduct any appreciable amount of market research.

Nevertheless, a considerable section of the potential research resources of the nation can be found in existing and planned social science research programs in industry, and there is a large opportunity to improve individual business operations and the conduct of economic affairs generally through scientific study of the social and economic factors involved in production and distribution. As their problems become more complex and technical in the fields of market analysis, taxation, and labor relations, businessmen are finding it essential to conduct research before making decisions. The increasing demand for government support of business research indicates a growing consciousness of needs in this field.

INDUSTRIAL RESEARCH IN THE SOUTH

When the figures for industrial research laboratories and workers in the southern states are extracted from the national ones, they present a picture both discouraging and encouraging, one of great deficiency by comparison with other regions, but also one of growth in recent years.

LABORATORIES

In 1938 the 11 southeastern states[8] reported 113 laboratories to the National Research Council, 5.1 percent of the national total of 2,234. If the laboratories reported from Texas and Oklahoma are added to those from the Southeast, the number for the 13 states is 160 or 7.2 percent of the total. A count of laboratory units from the 1940 directory shows 189 laboratories in the Southeast and 277 in the 13 southern states. In the second volume of *Research—A National Resource*, the total number of laboratory units in 1940 is

[7] "Motors," *Time Magazine*, XXXII (November 14, 1938), 66-70.

[8] For purposes of regional comparisons the six regions delineated in Howard W. Odum, *Southern Regions of the United States*, are used. In some instances Texas and Oklahoma are added to the Southeast (Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana) to make 13 southern states. Where this is done it is indicated.

given as 3,480. The number of units is larger than the number of companies because many companies have more than one laboratory. The Southeast reported 5.4 percent of the laboratory units in 1940, the 13 southern states, 8 percent. By 1946 the Southeast had 212 laboratory units, Texas and Oklahoma 119, making a total of 331 for the 13 states. Texas stands far above other southern states in the number of laboratories. Oklahoma, Virginia, Tennessee, Georgia, and Louisiana rank relatively high in the region, while Arkansas, Mississippi, and South Carolina come last. These relative positions have remained approximately the same over the period for which material is available.

Between 1927* and 1938 the number of laboratories in the Southeast increased 232 percent, the number in the Southwest 117 percent. These increases led those of all other regions and greatly surpassed the national percentage increase of 95. If Texas and Oklahoma are included with the Southeast, the percentage increase for the 13 states over the 11 years was 191. Industrial research was thus growing at a greater rate in the South than in other regions. It must be realized, however, that these rates of increase may be extremely misleading. The actual number of industrial laboratories in southern states has always been—and still is—so small that the percentages mean little, except that the region is moving in the right direction. While the Southeast showed an increase of 232 percent in the number of laboratories from 1927 to 1938 and the Northeast an increase of 82.6 percent, the actual numerical increase in the Northeast was more than six times that in the Southeast. Similarly, while industrial research personnel increased 376 percent in the Southeast in the same period and 114 percent in the Northeast, the actual increase in the Northeast was almost four times that in the Southeast. Table 1 gives the actual and percentage increases from 1927 to 1938 by regions. Figure 1, giving the geographical location of the laboratories included in the National Research Council survey in 1940, shows even more strikingly the concentration, outside the South, of the industrial research of the country.

The most important industries in the South have not been characterized by research, regardless of location. But other factors

* 1927 was the first year in which coverage was complete enough to give figures comparable with those of later years.

also have a part in producing or explaining the under-development of industrial research. The Southwest, for instance, has an industry in which research has been emphasized, petroleum. The number of research workers in petroleum in the Southwest increased from 161 in 1927 to 667 in 1938. Yet in 1938 Pennsylvania had almost twice as many research workers in petroleum and its products as Oklahoma and Texas together, although it had less than half as many wage earners in the industry in 1939. The industry is older in Pennsylvania and research was first established there. The tendency is to expand existing laboratories rather than to establish new ones. This partly explains the fact that in 1938 Connecticut had four times as many research workers in textiles as the whole Southeast, although it had less than a tenth as many wage earners in the industry in both 1937 and 1939.

TABLE 1. INCREASE IN INDUSTRIAL RESEARCH LABORATORIES AND PERSONNEL BY REGIONS, 1927 TO 1938

Region	Laboratories				Research Personnel			
	1927	1938	Increase	Percentage Increase	1927	1938	Increase	Percentage Increase
United States	1147	2234*	1087	95	18,982	44,247*	25,265	133
Northeast	625	1141	516	83	11,944	25,526	13,582	114
Southeast	34	113	79	232	253	1,204	951	376
Southwest	23	50	27	117	285	881	596	209
Middle States	373	760	387	104	5,765	14,869	9,104	158
Northwest	29	37	8	28	186	191	5	3
Far West	63	133	70	111	549	1,576	1,027	187

* These figures are different from those in the original tables because of the exclusion here of laboratories and personnel outside continental United States.

Source: George Perazich and Philip M. Field, *Industrial Research and Changing Technology*, Appendix A, Tables A-10 and A-11, pp. 69-72. The methods used to adjust the data for 1938 to make it comparable with that for 1927 are described in this report, Appendix A, pp. 54-57. Appendix A describes in detail the limitations of the data and the methods of adjustment and analysis used.

In this connection the extent to which the research laboratories located in the South are controlled by companies outside the region is of interest. The National Research Council lists all laboratory units separately, and the totals for states and regions do not distinguish branch laboratories from others. A sample count made directly from the 1940 directory suggests that between 35 and 45 percent of the laboratories in southern states are controlled by companies with home offices outside the region.

PERSONNEL

A detailed analysis of industrial research personnel by industry groups was made from the National Research Council data as a Work Projects Administration research project in 1938. This study makes it possible to determine how the personnel in the southern states between 1927 and 1938 was distributed among industries and what changes took place over the 11 years.

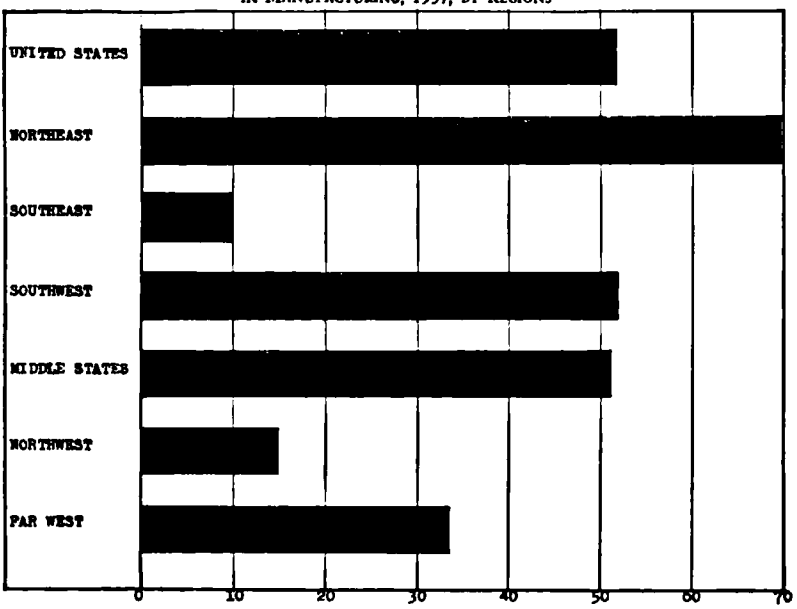
In 1927 the Southeast reported only 253 industrial research workers, 1.3 percent of the national total of 18,982. Of these, 149 were in chemicals and allied products. The 29 workers in metal products, and the 18 in stone, clay, and glass products were the next largest groups. There were only 10 people reported as doing industrial research in the field of petroleum and its products. Eleven years later, when the national total was 44,247, reports indicated 1,204 workers in the Southeast, 2.7 percent of the total. The number in chemicals had grown from 149 to 275, the number in metal products from 29 to 217, the number in petroleum from 10 to 252, the number in stone, clay and glass products from 18 to 90, the number in consulting and testing laboratories from 16 to 238. These made up 89 percent of the total. The two industry groups employing the largest number of workers in the Southeast, textiles and forest and paper products, had 13 and 17 research workers respectively in 1938. The increases which took place in the Southeast in this period of 11 years were in fields in which great increases occurred in the country as a whole. In other cases there was not an increase in the Southeast paralleling the national increase, even in industries prominent in the region. While the Southeast had 13 research workers in textiles in 1938 as against none in 1927, the United States increase was from 104 to 367, and the northeastern increase from 100 to 336. Similarly, in forest products the Southeast grew from 1 worker in 1927 to 17 in 1938, but the whole country grew from 337 to 944, the Middle States from 73 to 407, and California alone from no workers to 41.

Of the 881 research workers in the Southwest in 1938, 667 were working in petroleum and its products in Texas and Oklahoma. The percentage increase in workers from 1927 to 1938 was not so great as in the Southeast because the Southwest began with more. After petroleum, the industry groups with the largest numbers of

workers were chemicals and allied products, metal products, and consulting and testing laboratories. These fields included all but 18 workers in 1938.

If Texas and Oklahoma are added to the Southeast to make a region of 13 southern states, the total number of research workers in 1938 was 2,059, which is 4.7 percent of the national total. Of these, 45 percent were in petroleum and its products, 16 percent in chemicals and allied products, 14 percent in metal products, 14 percent in consulting and testing laboratories.

Figure 2. INDUSTRIAL RESEARCH WORKERS, 1938, PER 10,000 WAGE EARNERS IN MANUFACTURING, 1937, BY REGIONS



Source: Industrial research workers from George Perazich and Philip M. Field, *Industrial Research and Changing Technology*, Appendix A, Table A-10, pp. 69-71. Wage earners in manufacturing from *Biennial Census of Manufactures, 1937*, Part I, Table 3, pp. 20-21.

The poverty of the Southeast in industrial research is shown most strikingly when the number of research workers is considered in relation to the total number of wage earners in manufacturing. This ratio shows the relationship between an index of industrial research and an index of industrialization. Figure 2 shows the

position of the Southeast among the six regions, with 10 industrial research workers per 10,000 wage earners in manufacturing as against the national figure of 52.

The Northwest has few research workers, but it also has much less manufacturing than the Southeast and stands above the Southeast in number of research workers as related to wage earners in manufacturing. The Southwest differs markedly from the Southeast, being slightly above the nation as a whole in ratio of research workers to wage earners. This reflects the dominance of the petroleum industry in the region, and is particularly influenced by the inclusion of the research workers in oil producing, refining, and exploration. The Northeast is considerably above the national figure in spite of its large number of wage earners in manufacturing, and has seven times as many research workers per 10,000 wage earners as the Southeast. When the 13 southern states are taken together, the number of industrial research workers per 10,000 wage earners is 15.

PATENTS

A further indication that the South has provided relatively few new ideas and developments for industry can be found through examination of patents issued. The Southern Research Institute has summarized the number of patents issued during the period 1934-1943 to citizens of the various states, and has related the number to the 1940 state populations. If the 48 states are ranked according to number of patents issued in proportion to population in 1940, there is no southeastern state in the higher half; there are 7 southeastern states and 1 southwestern state in the lowest 10. No southeastern or southwestern state had more than 125 patents issued to its citizens in the 10 years, while 12 states and the District of Columbia each had more than 300. Delaware stands at the head of the list with 1,081 patents per 100,000 population, Mississippi at the bottom with 17. Figure 3 shows regional differences, with the Southeast behind all other regions.

CONSULTING AND TESTING LABORATORIES

In addition to the research of individual industrial companies for their own immediate or eventual use, scientific investigations

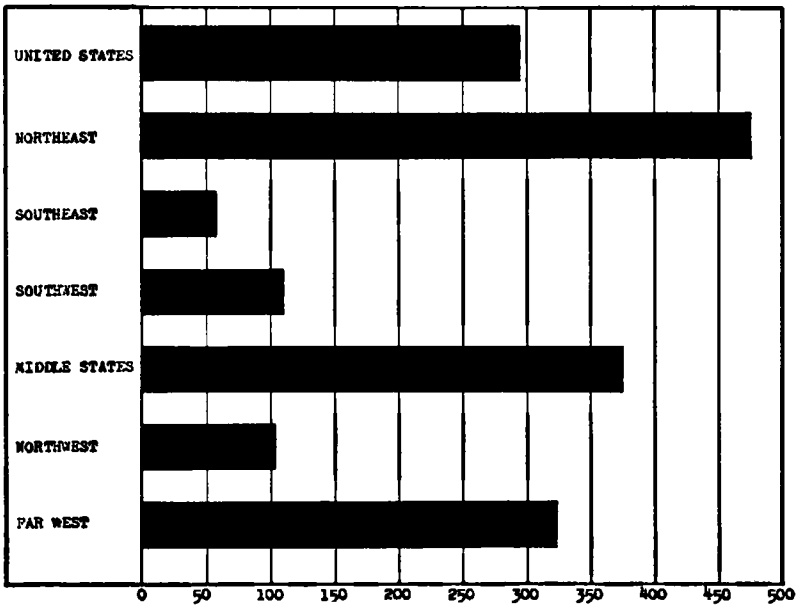
are conducted on a commercial basis by consulting and testing laboratories. These are included in the directories of the National Research Council and collateral studies, but some special attention should be given to them because of the different type of contribution they make to total research resources. In 1938 such laboratories in the 13 southern states employed 285 research workers, with only the chemical and petroleum industries employing more. Since these laboratories function chiefly to serve the industrial concerns which do not have research programs of their own, it is interesting to note regional variations in the proportion they compose of the total amount of research. This can be most accurately measured in terms of personnel. In 1938 consulting and testing laboratories employed 20 percent of the total southeastern research personnel reported to the National Research Council, 14 percent of that reported from the 13 southern states. Only 6 percent of the national total of industrial research workers were employed in these laboratories. This does not mean that the South has an undue proportion of the consulting and testing laboratories of the country. The Southeast reported only 9 percent of the total workers in this field in 1938. However, this figure is noticeably higher than the region's 2.7 percent of total industrial research workers.

A count from the *Directory of Commercial Testing and College Research Laboratories*, published by the National Bureau of Standards in 1942, shows approximately 12 percent in the Southeast, approximately 18 percent in the 13 southern states. These figures may be set against the Southeast's 5.1 percent of the total industrial research laboratories in 1938 and the 13 states' 7.2 percent. The differences indicate that the southern states are more adequately provided with commercial consulting and testing laboratories, in comparison with the rest of the country, than they are with industrial research units operated by individual companies to deal with their own needs.

There is here a suggestion that industrial research in the South may follow a pattern of relatively heavy emphasis on commercial and cooperative research organizations. The financial cost of elaborate laboratories is prohibitive for small companies, and it is usually easier to begin research by using commercial research facilities. Another means whereby small concerns may secure the

services of specialists is the employment of consultants, especially industrial engineers. Agencies in a number of southern states are surveying the availability of these services to industry.

Figure 3. NUMBER OF PATENTS AND DESIGNS ISSUED TO CITIZENS, 1934-1943, PER 100,000 POPULATION, 1940, BY REGIONS



Source: Number of patents from compilation by Southern Research Institute of data from United States Commissioner of Patents. Population from *Statistical Abstract of the United States, 1941*, Table 12, p. 10.

PRIVATE AGRICULTURAL RESEARCH

Special mention should be made of the plant breeding and other agricultural research conducted by seed companies in southern states. These research activities are of great importance to a region still heavily dependent on agriculture for its economic well-being. They are in some ways like the research of an industrial concern which is seeking to increase profits by improving its products and finding new ones. In other ways this agricultural research has a more general import because its benefits extend into

the operations of the individual farmer and affect his financial returns. This extension of the benefits of research can be traced in most fields, but the line is rarely so direct and obvious as here. Plant breeding takes time and careful planning and control. The presence in the South of a number of large companies with extensive breeding programs indicates that private research can be conducted profitably in these regions, even in a field where it is easy to make the assumption that only governmental research is practicable. Plants have been bred for characteristics to give them additional value, for adaptability to climatic conditions, and for disease and insect resistance. The goals of the investigators are constantly changing to meet the requirements of markets and new problems of production.

SOCIAL SCIENCE RESEARCH IN SOUTHERN INDUSTRIES AND BUSINESS FIRMS

Available material does not permit similar regional analysis of business and economic research by private concerns, but indirect evidence points to a condition similar to that presented for industrial research. If research is used in one field, its value in another is more likely to be realized. If the tendency is to get along without scientific study in connection with production, it seems probable that no great provision is made for market and supply analyses and other social and economic studies. It is undoubtedly the case that large concerns in the South use research in management and employ advertising firms who conduct marketing research, but the bulk of southern business and industry is in small units. The probability is that their use of social science research is at a minimum.

The United States Department of Commerce *Market Research Sources* for 1940 lists 22 studies made generally available by individual business concerns, none from the Southeast or Southwest. There are also no listings for business services in the Southeast and only one in the Southwest. This material does not attempt to cover the use of social science research by business concerns for their own private use. It does support indirectly the assumption that the South is deficient in this field of research, as in others.

RESEARCH THROUGH COOPERATION OF INDUSTRIAL AND BUSINESS COMPANIES

Research in both the natural and the social sciences is conducted by associations of business firms. In the South, where many companies are small and cannot afford separate research programs, the potentialities of this cooperative research are of special significance.

Railroad and Utility Companies

A special type of service program which may include research and usually does include collection and compilation of research findings is represented by the activities of agricultural and industrial development divisions of railroad and utility companies, and by similar activities of a few large industrial concerns directed toward community or regional development. The railroad and utility companies have a heavy stake in the economic well-being of the areas they serve and accordingly devote attention and money to assisting industry and agriculture.

Often the development programs are limited to the collection of resource information which can be used in advertising and personal efforts to get new industrial plants, but occasionally preliminary tests are made of new materials for adaptability to industrial use. The laboratory work may be arranged through commercial laboratories or, more rarely, conducted by a permanent technical staff. Because of their interest in new industry these companies may also help to finance scientific study of new products and processes by other research agencies. The agricultural development programs consist largely of collecting and distributing the results of agricultural research which will assist farmers to increase and improve production, and of encouraging recommended farming practices.

As a result of these development programs the larger railroad and utility companies have compiled quantities of data about the resources of special areas. Some of this is general material collected from other agencies. Some of it is in the form of detailed studies of particular situations for specific companies and is not available for the use of anyone else. If there could be improved coordination of the work of all those in the southern regions who

are trying to provide basic data on industrial opportunities and coordination of research in order that the most urgent subjects be given priority and duplication of effort be avoided, these agricultural and industrial development departments could become important units in a region-wide program. Realization is growing that benefits from industrial expansion are temporary unless such expansion is soundly based on local resources and conditions. Correspondingly it becomes clear that the development of the whole region, with local and area specialization based on complete knowledge of relative advantages, will bring greater benefits to the companies providing transportation and power than competition based on incomplete knowledge and special pleading.

Trade Associations

For business units without research organizations of their own, the trade association provides a means of financing research cooperatively. Science can be applied to problems common to all the members of the association, while the specific adaptation to each plant is left to control laboratories, to arrangements with commercial laboratories, and to company planning staffs. Or the association may arrange to finance a research program through existing research agencies without actually maintaining a research unit of its own. There are certain obvious advantages to cooperative research of this sort. It is an economical way to conduct fundamental research, eliminating duplication of effort and permitting the investigation of problems broader than those of any one firm; it permits all sizes of firms to participate in research activities; and it tends to prevent delay in the use of research findings which may result from suppression through monopolistic control of research.

For regions just beginning to appreciate their need for research and without great financial resources, cooperative research through associations would seem to offer many opportunities. Careful organization, selection of important problems, and skilled personnel are required to make these research programs effective, but the requirements can be met if able leadership is provided from the interested concerns. At the present time there is great variation in the amount and effectiveness of the research conducted by trade

associations. Economic or statistical studies are more common than laboratory research, while the great majority of trade associations have no research activities. The United States Department of Commerce reports that 420, or 15 percent, of the trade associations listed in its 1942 directory carry on technical or industrial research, while 550, or 20 percent, conduct commercial or marketing research.

Trade Associations in the South. Southern business and industry participate in regional and national trade associations, although the exact extent of the participation is difficult to estimate. If the location of headquarters has any relation to the emphasis of activities, the South remains on the fringes of the interests of national associations, and these are the ones with the most extensive research programs. The 1942 United States Department of Commerce directory, *Trade and Professional Associations of the United States,* shows 60 percent of the 2,800 listed associations with headquarters in three cities—New York, Chicago, and Washington. There are 16 cities with 20 or more associations each. Two of these are in the South, New Orleans with 21 associations and Atlanta with 20. These 41 associations may be compared with the 1,497 in the five northeastern cities with 20 or more associations. One would expect to find the headquarters of trade associations in the parts of the country where financial and industrial interests are concentrated, and in the national capital, but this factor influences the possible effectiveness of national trade association research in meeting the needs of the South. A count made from the directory shows 30 associations in the Southeast reporting industrial research, 35 reporting commercial (social science) research, seven and six percent respectively of the national totals. The replies received to inquiries made directly to these associations suggest that these figures give an exaggerated impression of the actual amount of research done.

The few trade associations which are doing effective research in the South are primarily national organizations whose interest is focussed on a southern product, such as cotton or petroleum. For the most part regional trade association activities are limited to promotion and publicity, protection of trade interests through influence on legislation, and standardization of products and pro-

cesses. In some cases statistical information on production and marketing conditions, as well as summaries of legislation, are collected and distributed regularly to members. Some of the regional associations are beginning research activities by contracting for projects with commercial research laboratories, or by supporting projects in universities, agricultural experiment stations, or private research institutes. The laboratories used are both within and outside the South.

Regional trade associations also participate, as members, in national association research programs. An instance of widespread participation and support is the hardwood research program of the National Lumber Manufacturer's Association. A number of southern regional associations in the forest products field are contributing to this research, and individual lumber or wood products companies participate through the regional associations. In this case, research of importance to southern industry is being conducted on a national basis and the interested southern groups have an active part in the project, even though the actual work is being done outside the region.

A Research Opportunity. Further extension of research through trade associations depends upon the degree to which the members feel a need for it. If southern business and industry find regional associations necessary to protect their interests in other fields, they may also find it desirable to meet fundamental research needs through cooperative programs. Officials of some of the existing associations are fully aware of the opportunities in this field, and research committees are being appointed to study the needs and possibilities. Practical results will depend on the willingness of member firms to contribute financial support. Cooperation with existing research agencies offers the opportunity to begin a program without the expense of establishing separate laboratory facilities. At the same time additional support given to commercial research agencies and to university laboratories will enable them to expand their facilities and offer increasingly effective service.

There are, however, certain obvious limitations to the ability of trade association programs to satisfy all research needs. Projects should be general and of common interest and benefit to all members. The various types of member companies must be reconciled

to the programs and this is not always easy. Any failure to satisfy members removes financial support. Consequently there are research activities that each company has to provide for itself if it is to have them. In addition, the ability of a company to benefit from trade association research or any similar cooperative endeavor is dependent in part on its possession of a technical staff to interpret and apply research findings. Some companies feel strongly that research must be an integral part of their own organization. The research director of a southern firm writes:

> At one time or another we have tried group research with others, direct purchase of information, reliance on governmental or institute laboratories, but none can compare in our experience with a permanent and active group on the payroll with their hearts in the work—and we are a typical "smaller business."

One type of service especially suited to trade associations is the collection and distribution of research data to members. The bulk of scientific reports is so great today that it is extremely difficult for business concerns, even those with adequate technical personnel, to keep informed about scientific findings which might be of interest to them. Some trade associations now do this, but the quality of the work could be improved and more associations could undertake it.

Banking Companies

In a service related to industrial research which has been instituted recently by a few banking companies, information is supplied to customers about available research assistance. The bank recognizes the sound business value of research and by this means encourages its use. A special department acts as an intermediary between the customer with a problem and the technical expert who can help with it, emphasis being on direction to the appropriate qualified expert. The Wachovia Bank and Trust Company, with headquarters in Winston-Salem, North Carolina, provides an example of this type of service.

Private Research Institutes

Private, endowed research institutes are an important part of the total research resources of the nation, but a part in which the

South has not shared until recently. Equipment and personnel can be concentrated in these research centers which provide facilities of superior quality for small industries and trade associations without their own laboratories and engage in investigations requiring highly specialized equipment. More important, the endowment permits fundamental research in addition to the contract services for individual concerns. Here is the means of securing the advantages of a large research organization for those who cannot individually afford the cost.

As appreciation of research spreads, the lack of private research centers is being felt in the South, and concrete steps have already been taken to provide such facilities. The Southern Research Institute, located in Birmingham, Alabama, is a non-profit organization sponsored by southern business interests. Buildings and equipment are provided out of funds raised by private subscription, and since 1946 operating costs have been fully covered by overhead charges against sponsors' accounts. Growth of the Institute has been rapid since it accepted its first research assignment in the spring of 1945. At the end of 1947, the organization comprised about 80 people, including 50 men and women on the technical staff, and research was being conducted for sponsors at the rate of over $350,000 per year. The physical facilities consist of four temporary buildings and a new permanent building with approximately 22,000 square feet of floor space. A technical library supplements the research activities. Both the research program and the facilities of the Southern Research Institute are broadly oriented, including such fields as food technology, biochemistry, chemotherapy, organic and inorganic chemistry, plastics, paints, wood and paper technology, textiles, engineering analysis and design, metallurgy, physics, electronics, etc. In 1947 the Institute initiated a program of research on its own account aimed at supporting work on regional commodities, encouraging initiative and originality of staff members, and advancing the frontiers of scientific knowledge. Staff members are encouraged to take part in all kinds of professional activities and to publish technical and semi-technical articles and books.

The establishment of this Institute is an admirable example of how regional development is furthered through cooperative efforts to meet individual and group needs. A research institution of great

value to the South has been built by private businessmen who pooled resources to meet a common need. Operating independently of other institutions and without public support or control, it is dedicated to the service of industry, but the South as a whole benefits directly and indirectly from its program.

The Institute of Textile Technology is not specifically regional in interest or membership, but its location in Charlottesville, Virginia, adds greatly to the research resources of the South, and its service will be of incalculable value to one of the predominant industries of the region. This Institute's program is restricted to the interests and needs of the textile industry, for which it provides research information and facilities and a specific technical training program. Regular publications distributed to members digest the material in textile publications and report the results of Institute research. A technical library and consulting service is also available to members. A graduate training course for a selected group of students, leading to the M. A. and Ph. D. degrees in textile chemistry and textile technology, is combined with the laboratory research program. The latter includes specific projects on a fee basis for members and a general program by staff members and students. This example of cooperative effort to support research and to provide technically trained specialists is particularly noteworthy in an industry where research has previously been at a minimum.

Chambers of Commerce

Chambers of Commerce represent business and industrial interests on an area rather than on a functional basis. These organizations, both city and state, have been primarily interested in promotional and protective activities. However, a protective program may include a research committee working in the field of taxation and finance, and promotional activities sometimes result in collection of scientific data. Increasingly, attracting new industry to a community or state depends upon accurate and detailed information on a variety of specific matters relating to natural resources and social and economic conditions. A few southern chambers of commerce have made resource surveys recently, and some have also worked to encourage needed research

on resources available for industrial development. There is widespread cooperation with groups like the Committee on Economic Development, regional Farm Chemurgic Councils, the Southern Association of Science and Industry, and state industrial development agencies.

As chambers of commerce move from uncritical community self-praise toward emphasis on specific needs and practical opportunities, they can play an important part in promoting a scientific approach to the economic problems of the South. Research is expensive, and the business community will have to appreciate its value and be willing to support it financially if the South is to make the most of its present opportunity to build a sound program for the use of science to bring well-being to its people. Furthermore, widespread use of research by small business units depends upon knowledge of what material and services are now available to them from various sources. The educational opportunities of chambers of commerce in this field are great. There are few ways in which concerted effort by businessmen could be more effective in helping the individuals concerned and the region as a whole. The work of a few chambers at the present time points the way. Many more effective units are needed throughout the southern states, as well as more dynamic programs for most of those now in existence. Cooperation between research agencies and chambers of commerce should be extended. The South cannot afford the luxury of misunderstandings and distrust between its scientists and its businessmen. Each can help the other, particularly if both concentrate on the common goal of regional improvement.

Committee for Economic Development

The work of the Committee for Economic Development, a special organization of businessmen and industrialists, with national, regional, and local units, has been helpful in promoting cooperative study of business conditions, resources, and needs by businessmen themselves. The program of the national research committee of the organization provides for the study of general economic questions by experts, but the plan for local study by local groups has reached into many southern communities, chiefly the larger ones. The regional offices collected estimates of postwar employment needs and opportunities resulting from local com-

munity surveys, but the emphasis is upon local use of this material. The organization plan calls for a research committee in each local unit. There is, of course, great variation in the quality of the work done in local communities and in the coverage attained by the organization in different states and areas, but the influence of the national program and the effort to arouse local groups to study their special problems has been widely felt. Often there has been cooperation with and consequent stimulation of chambers of commerce and other local groups. In Louisiana the State Committee was given semi-official status and was thus able to carry out an elaborate program in collaboration with other state agencies, and its activities were later taken over by the state.

Committee of the South

Early in 1946 the National Planning Association initiated steps which led to the formation of a Committee of the South made up wholly of southerners active in the various fields involved in regional development. The purpose of the Committee is to make "an adequate study of economic conditions of the South, expertly conducted." Financed by foundation funds, the Committee has employed on a part-time basis several professors in southern institutions and the research is under way. Research planned by the Committee includes studies of industrialization and agricultural development, population movements, and research facilities.

A PICTURE OF INADEQUACY

This material on the status of industrial research in the southern states is admittedly incomplete. The National Research Council survey is voluntary and omissions are inevitable. There is no practical way to canvass the smaller research units, and a sampling procedure is used for them. Yet there seems to be no question but that the data are adequate to give a general account of industrial research in the country and to permit regional comparisons. Clearly the South does not have the industrial research which it needs.

The Inadequacy Continues

Although the 1946 edition of *Industrial Research Laboratories of the United States* shows that the trend toward increasing use of

industrial research has continued in the South, the total amount is still relatively small and falls far short of the region's needs. Correspondence with companies maintaining laboratories in the South suggests that no important or extensive changes in emphasis have taken place since the detailed studies were made in 1938 and 1940. Most laboratories which are maintained are devoted chiefly to the practical testing problems associated with production operations and do not carry on additional research. The chemical and petroleum industries still lead in the use of research, with some indication that scientific work has been increasing in the general field of forest and paper products. Many national companies with extensive research programs operate branch plants in the South, but usually their research is not conducted in the region. It may be that the movement of the chemical industry toward the raw materials and favorable operating conditions of the South will bring with it a considerable expansion of research, but this has not yet taken place.

This summary does not, of course, do justice to a number of southern industrialists who are fully aware of the value of research and have laboratories completely adequate for the needs of their operations. A few of these also cooperate with colleges in research training programs and conduct investigations to help their suppliers of raw materials or their customers. Their practices are encouraging exceptions to the general situation, but they are not numerous enough to affect the whole a great deal. Even as far back as the 1880's the sugarcane industry showed what could be done through research when it saved itself from threatened destruction by beet sugar competition through establishment of an experiment station for research and training of technical workers. This highly successful project is represented today by the Audubon Sugar School at Louisiana State University, where it was located after being taken over by the state. Other particular instances of successful research programs could be given in detail and they would sound well, but it is more accurate to stress the over-all lack. The purpose of this survey is to present a general account of regional resources and needs, not to cite specific instances which are exceptional.

Some of the industries using research are small, some are large. There seems to be no reason why their procedures could not be

followed by many others. One can only hope that the establishers of branch plants will find that research is needed on the scene of operations; but one can urge that southern operators investigate the advantages to be derived from expenditures for research. There are signs that industrial research will expand in the region as it becomes easier to secure equipment and trained personnel. However, the expansion plans are mostly in organizations where there is already active research. There is little evidence that the great need for extension of research to industrial firms not now using it, both large and small ones, will be met, although it must be noted that investigating procedures would naturally lead to industries conducting research and not to those merely planning its use.

THE CHALLENGE TO SOUTHERN BUSINESSMEN

The increasing industrialization of the South makes it inevitable that a greater use of research will develop. American industry has learned well the value of using science. The question is in part one of how the industrialization is to take place. If it consists chiefly in the opening of branch plants of large national companies, there will be use of research but probably not of research conducted in the South. The region will benefit, but not to the extent which would be possible if it could use its own talents to develop its own resources. There are many operational advantages resulting from the centralization of research in relatively large units, as evidenced by the tendency toward increased size of laboratories, but this does not mean that research cannot be employed profitably by small concerns which can support only small research staffs. Indeed, it may well be argued that scientific advance will be promoted by the encouragement of research in smaller, more independent units where direction and control are less rigid. Certainly the combined needs of the southern regions, which include human needs for training and opportunity to use training, as well as needs for increased income, improved management, and wiser utilization of resources call for more research at all levels. The answer may lie partly in further use of commercial research agencies and collaboration of industrial groups for research purposes, but for optimum results it must also lie in the maximum use of science by each industrial company in its own operations, whether that maximum

be relatively small or great. The best argument for expansion of research is the fact that the companies which use it are unanimous in their acknowledgment of its value.

Private industrial and business development theoretically takes place along lines which promise the greatest profit to owners and managers. Community or regional welfare is not ordinarily a factor in decisions about industrial location or expansion or management policies. Many businessmen are aware that they depend ultimately on a prosperous nation and they are willing to take part in programs aimed at improvement. Nevertheless, the immediate problems which have to be met from day to day are handled in the light of other considerations. Simple exhortations to businessmen to increase their use of research are not likely to have great influence.

A large industry which is organized on the basis of a central research laboratory in New York or Chicago to serve branch operating plants located throughout the country will not be moved by appeals from southerners based on regional needs for the occupational opportunities and educational advantages of southern research units. An educational and promotional program might appeal to the southern industrialist, but the education and promotion must include demonstrable financial benefits and practical possibilities if it is to be effective. The way for groups interested in regional advancement to promote private industrial research is through development of trained technical personnel ready to go to work in the South, of agencies through which industries can actually participate in research without the initial cost of an independent laboratory, of general public appreciation of the contributions that scientific procedures can make toward the solution of all types of problems.

The demand grows for Federal Government research assistance to small industry, comparable to that provided for agriculture. It will continue as long as large sections of American industry are handicapped by present concentration and centralization of research. The concentration in certain fields results in lack of balance among the parts of the industrial community, and the concentration in certain areas results in a further lack of balance among the regions of the nation. The trend toward greater concentration, resulting in part from the relatively advantageous

position of those already possessing research establishments, will increase imbalances if nothing is done to counteract it. The backward industries and regions must secure help from some source if the health of the whole is to be maintained.

To the extent that southerners find ways to increase research by private means, they avoid the problem of control which inevitably accompanies governmental assistance. This survey, incomplete as it is in details, shows the existence of a base upon which more industrial and business research might be built in the South. It is not a sufficient base to meet regional needs in the near future, but expansion and coordination of existing agencies would provide a beginning. It is also necessary that the South take its place as a full-fledged and integral part of the economic life of the nation. In industrial and business research, as elsewhere, development of local facilities must be paralleled by participation in national research activities. Active membership in organizations like the American Society for Testing Materials, the Engineering Foundation, and similar ones, and in the special technical organizations of particular industry and professional groups is a part of such participation. This is impossible without men and women competent to be participants.

The need for more and better training recurs, no matter what approach be made to a program of regional development. Every concrete proposal depends finally upon the personnel to put it into effect. Industrial research cannot be greatly increased in the South unless southern businessmen look beyond their immediate problems and concern themselves with the whole institutional development of the region.

III

RESEARCH IN COLLEGES AND UNIVERSITIES

THE ROLE OF THE UNIVERSITY IN THE RESEARCH WORLD

THE FUNCTIONS OF UNIVERSITY RESEARCH

THE essential core of the research resources of any geographic area in present day society is in its colleges and universities. These institutions not only provide the greater part of the fundamental investigations upon which applied research workers depend; they also provide the training for research workers in all fields, applied and fundamental. They constitute the base upon which all research activities must, in the end, rest. This is true in spite of some increase in the amount of fundamental research conducted by both private industry and governmental agencies, and the appearance of a few training programs outside the universities. These supplementary developments serve chiefly to indicate the inadequacy of existing college and university facilities and activities; they have not been on a scale to meet the need produced by that inadequacy, nor is it likely that they can develop the conditions which make the university so peculiarly fitted to fulfill its role in research. In a period of growing concern about the country's dependence on an expansion of scientific research, the key position of colleges and universities and their potentialities for enlarged research programs focusses attention on these institutions.

Obviously industry is concerned with research because of its practical, money-making applications. Fundamental research is the effort to expand the area of scientific knowledge without regard to specific ends—literally "to follow knowledge like a sinking star, beyond the utmost bound of human thought." Financial returns from this type of research are not certain and are rarely immediate or direct, while the time required may make the cost great. Furthermore, the discoveries are not predictable and can rarely be controlled for the sole benefit of the persons supporting the research. Under these conditions private industries cannot be expected to undertake directly the broad and continuing basic research program which we must have.

Fundamental research is most fruitful in working situations

characterized by individual freedom, with no restrictions on subjects and methods, and with great latitude for the individual investigator to pursue his own line of interest wherever it may take him. In our society these working conditions are most nearly met in colleges and universities and the privately endowed research institutes. The latter, important though they are, do not offer the widespread possibilities for expansion of research activities found in the colleges and universities of the country. However the support necessary to maintain basic research at the level required for the national welfare is secured, here is the institutional framework within which the program should be conducted.

The critical importance of fundamental research to the nation as a whole was heavily stressed in the report made in 1945 by Dr. Vannevar Bush, Director of the Office of Scientific Research and Development, on ways in which the federal government can aid research and training for research, and it is further elaborated in the series of reports of the President's Scientific Research Board, *Science and Public Policy*, published in 1947. The committees working under Dr. Bush to discover means of encouraging basic research in the natural sciences found the richest opportunities in further development of university research.

> The unpredictable nature of pure science makes desirable the provision of rather special circumstances for its pursuit. Pure research demands from its followers the freedom of mind to look at familiar facts from unfamiliar points of view. It does not always lend itself to organized efforts and is refractory to direction from above. In fact, nowhere else is the principle of freedom more important for significant achievement. It should be pointed out, however, that many branches of pure science increasingly involve the cooperative efforts of numerous individuals, and expensive capital equipment shared by many workers.
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> Several factors combine to emphasize the appropriateness of universities for research. The university as a whole is charged with the responsibility not only of maintaining the knowledge of the past and imparting it to students but of contributing to new knowledge of all kinds. The scientific worker is thus provided with colleagues who, though they may represent widely differing fields, all have an understanding and appreciation of the value of new knowledge.[1]

[1] Vannevar Bush, *Science the Endless Frontier* (Washington: Government Printing Office, 1945), pp. 75-76 and 84.

The 1947 Scientific Research Board report recommended specifically:

> 3. That the Federal Government support basic research in the universities and nonprofit research institutions at a progressively increasing rate, reaching an annual expenditure of at least $250 million by 1957.[2]

The central position of colleges and universities in the research world comes not only from their function as centers of fundamental research. Even more essential is the provision of the technical training upon which the entire structure of scientific advance depends. The *sine qua non* of research is trained brain power, and training becomes increasingly important as the mass of already discovered knowledge becomes greater and more complex, and skill in investigation techniques more essential for success. The necessity of a high level of training for research workers in pure science has long been taken for granted, but the recognition of similar requirements for applied research workers is more recent and of great significance because of the large numbers involved. The requirement of graduate training as a prerequisite for industrial research positions is common today, and for many the doctorate or its equivalent is considered necessary. In recognition of the nation's dependence on a continuing supply of trained scientific workers for security and prosperity, possibly for survival, the Scientific Research Board recommended:

> 5. That a Federal program of assistance to undergraduate and graduate students in the sciences be developed as an integral part of an over-all national scholarship and fellowship program.
>
> 6. That a program of Federal assistance to universities and colleges be developed in the matters of laboratory facilities and scientific equipment as an integral part of a general program of aid to education.[3]

Other functions related to the development and increasing use of research can best be performed by colleges and universities, particularly public ones. These are the promotion of greater appreciation by all people for the value of research, and the encour-

[2] John R. Steelman, *Science and Public Policy, Volume One: A Program for the Nation* (Washington: Government Printing Office, 1947), p. 6.
[3] *Ibid.*, p. 7.

agement of wider application of the scientific method in order that all may share in the gains that come from scientific discoveries. This function is performed partly through the educational program for students and partly through relationships with the community and region within which the school is located. The agricultural extension services operating in connection with the land-grant colleges are an example of what can be done in this latter field. There has been increasing interest in the development of means to make the results of research available to larger numbers of people through special techniques of presentation and dissemination.[4]

THE ORGANIZATION OF UNIVERSITY RESEARCH

For the most part research activities grew up in American colleges and universities after their establishment and operation as teaching institutions. Since the opening of The Johns Hopkins University in 1876, however, the number of graduate schools has increased steadily, and now research is recognized as an essential part of any complete university program.

Like many changes in university structure and function, the introduction and development of research has followed no specific pattern. It has been more highly developed in some fields than in others, and there is great variation among institutions with regard to all features of research activity. More often than not university research has consisted of the persistent efforts of individual scientists working alone and without institutional encouragement and assistance. The medical schools were among the earliest beneficiaries of money grants for more elaborate research programs, and it is noteworthy that the United States was more nearly a leader in this field of research than in any other in the prewar period. Recently there has been a general trend toward more formal recognition of the research functions of the university and more organization of research activities. Research in the social sciences, which in point of time has tended to follow that in the natural sciences, has frequently started with the establishment of a research bureau or institute.

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[4] The Committee on Southern Regional Studies and Education of the American Council on Education has been doing pioneer work in this field. See John E. Ivey, Jr., *Channeling Research into Education* (Washington: American Council on Education, 1944), and *Education for Use of Regional Resources* (Washington: American Council on Education, 1945).

Research in Colleges and Universities

The most important factor in college and university researc resources is the quality of the personnel available for research and training. However, resources include also all the various kinds of material aids to the research worker—laboratories, libraries, and technical assistants. Further, the effectiveness of existing resources is in great measure determined by the intangible, but nonetheless important, general attitude within the institution toward the worth and significance of research. Too often heavy teaching loads leave no time available for anything else, even when research is given high value in policy statements and advancement procedures. There is no real incompatibility between research and teaching, but there are great and fundamental differences among institutions with regard to the active encouragement and support of research as a necessary part of the training function of the school.

An itemized account of all aspects of university research resources is obviously impossible, since many important ones are not measurable. Even the features which might be counted and objectively evaluated are not clearly separated from other parts of institutional structure and function; often neither personnel nor equipment is assigned separately to research and instruction. A real inventory of university research resources would necessitate a detailed first-hand investigation of each institution. This is not desirable now, even if money and workers were available, since conditions during and following the war have been abnormal, and rapid and unpredictable changes are taking place. Nevertheless, the general status of research in colleges and universities can be indicated and fitted into the broad outline of all types of research resources. The figures to be used in this general description come from many different sources; they refer to different years; some of them are estimates only; they do not cover all aspects of university research resources; and they do not take account of the many qualifying conditions which would be important in judging the relative research merits of individual institutions. They should not be interpreted, either singly or collectively, as exact measures of research activities; taken all together they throw light on the research situation in colleges and universities.

Heaviest emphasis is given to data for the period immediately preceding the war. During the war period research training declined sharply, although federal government contracts increased

the amount of research being conducted in the colleges and universities. Since demobilization the number of students in training has increased enormously. At the same time the quality of training has probably declined because of overcrowding and the relative shortage of high grade instruction. Government research, largely military, still accounts for a larger part of college and university research than it did before the war, and at the same time many schools are trying to enlarge their contract research services for private industry. These developments both tend to be at the expense of fundamental research activities.

A more detailed investigation bringing together all existing information about research facilities in universities and colleges, and supplementing this with case studies, should be undertaken within the near future. Certainly there should be more complete information about the research centers which already exist and are growing up around special fields of study. Industry, government, prospective students, and universities themselves would find this material useful. Part of the relevant data was collected by federal agencies during the war and it should be made widely available. It would be of particular help to institutions planning to expand research activities and to those people who may handle the proposed government grants for research and research training. Many of the advantages of coordinated and cooperative research which were demonstrated during the war can be permanently secured without sacrifice of the freedom and initiative which are essential to productive inquiry, but planned cooperation is dependent upon knowledge of the potential contributions of the various units involved.

THE EXTENT OF UNIVERSITY RESEARCH

There are between 1,700 and 1,800 institutions of higher education in the continental United States. This total includes colleges and universities, professional schools, teachers colleges, normal schools, and junior colleges. In one sense, these are all a part of the nation's resources for training potential research workers, but the number conducting research and giving direct research training is much smaller than the total.

Dr. Raymond L. Hughes, who has made special studies in this

field for the American Council on Education and the National Resources Committee, made the following estimates of participation in research in the middle thirties:

> There are from 10 to 20 institutions that are in every sense universities. The staffs of all departments are selected with a view to research ability. Facilities and time are specifically available for research. In 80 to 100 other institutions research is a recognized part of the work of certain departments, but not of all. Some conduct research at a high level. Part of the staff only is selected with large emphasis on research ability. In perhaps 50 or 100 additional colleges the administration gives some encouragement to research. In the remaining 1,200 institutions classed as colleges . . . research is very slightly or not at all encouraged, is almost wholly a matter of individual initiative, and is carried on in spite of very full teaching schedules. Of necessity "research" has a different meaning in these very different environments.[6]

The Hughes study found 98 institutions reporting funds specifically budgeted for research in 1935-1936, and estimated that 150 colleges and universities spent about 98 percent of the total money spent for research by all such institutions. In 1939-1940 the number reporting separately budgeted research expenditures to the United States Office of Education was 175. On the basis of the questionnaire returns received in his more recent study, Dr. Vannevar Bush estimates that about 150 colleges and universities have organized research programs in the natural sciences and engineering. The number with social science research programs would almost certainly be smaller. The 1946 edition of *Industrial Research Laboratories of the United States* includes an appendix listing 292 colleges and universities which offer some kind of research service to industry. E. V. Hollis, in *Toward Improving Ph. D. Programs*, reports that 96 different graduate schools awarded the doctor's degree in the decade of the thirties. The Association of American Universities, an organization limited to institutions which have demonstrated superiority in graduate training, has only 32 United States members.

The number of people who are given research training has been increasing, particularly in the period since the first World War. United States Office of Education figures show 3,497 doctor's de-

[6] National Resources Committee, *Research—A National Resource. I. Relation of the Federal Government to Research* (Washington: Government Printing Office, 1938), p. 169.

grees and 24,648 master's or equivalent degrees conferred in this country in 1941-1942. The numbers had decreased to 2,305 and 13,414 in 1943-1944, but they should increase again rapidly in the next few years. It is not the case that this number of highly trained people is made available for research annually, because many of the degree holders go into teaching and other non-research occupations. These figures do serve as an index of the postgraduate training facilities of the colleges and universities. In addition there are courses below the graduate level which provide some research training.

Before the expansion made necessary by the large numbers of veteran students, there were around 150,000 staff members in United States institutions of higher education. Between 105,000 and 110,000 were conducting resident classes of college grade, and a very much smaller number would cover all who were devoting full or part time to research and training research personnel. Dr. Hughes estimated that at least 15 percent of college and university teachers carried on research at the time of his study in the middle thirties. The number reported to the Office of Education as specifically assigned to organized research in 1941-1942 was 5 percent of the total staff members. Although the same Office reports an increase of 2,000 in the number of persons engaged in research activities between 1939-1940 and 1943-1944, the proportion remains small. However, the quality of college and university research personnel has been high. *Science and Public Policy* estimates that colleges and universities had 58 percent of the 14,000 persons holding doctor's degrees in the physical and biological sciences in 1937. The percentage was down to 50 in 1945 and had climbed back as far as 53 in 1947. These institutions employed 73 percent of the starred men in the 1938 edition of *American Men of Science*. Generally, it seems conservative to conclude that something more than half of the superior research men and women of the country have been concentrated in educational institutions. This goes far to explain the achievements of university research despite limitations of time and money.

On the basis of his 1935-1936 figures, Dr. Hughes estimated that colleges and universities were then spending around 50 million dollars annually on all research. With somewhat more exact figures as a basis, Dr. Bush's report gives an estimate of 26 million

dollars for the natural science and engineering research expenditures of 150 institutions in 1939-1940. The *Science and Public Policy* reports estimate that universities spent 20 million dollars on research and development in the physical and biological sciences in 1930; 31 million dollars in 1940; and 10 million dollars as a yearly average in the period 1941-1945. The amount reported by institutions of higher education to the Office of Education as budgeted separately for all organized research in 1941-1942 was 34 million dollars; by 1943-1944 the amount so reported had increased to more than 58 million dollars. The amount spent through federal government contracts during the war would greatly inflate these figures, but it cannot be regarded as a part of the regular university programs. This type of research has declined somewhat, but the enlarged research program of the federal government is still partly conducted through university contracts and in laboratories run cooperatively with universities.

Research training has been a relatively recent development in this country, with the great bulk of the growth taking place after the first World War. The number of institutions conferring Ph. D. degrees increased from 25 in 1876 to 89 in 1942, the number of doctorates conferred from 44 in 1876 to 3,497 in 1942. In the 44 years between 1876 and 1920, 19 additional institutions began awarding doctor's degrees; in the 22 years between 1920 and 1942, more than twice as many were added to the list. In 1920, 488 more doctorates were awarded than in 1876; in 1942, 2,965 more were awarded than in 1920. There was also great expansion of buildings and equipment for purposes of scientific training and increased attention to technical training below the graduate level.

THE RATIO OF FUNDAMENTAL TO APPLIED RESEARCH

These figures are impressive when taken alone, but much less so when examined in relation to the increase in industrial research over the same period. The analysis of all research expenditures made for *Science the Endless Frontier* shows that these educational institutions, which provide most of the fundamental research and almost all the research training, have been lagging behind developments in both industrial and governmental research to a degree promising serious problems for the future. Between 1930 and 1940

the scientific research expenditures of industry and government more than doubled; those of colleges and universities increased by one-half, and those of endowed research institutes declined. When Dr. Hughes made his report in the middle thirties he concluded that all his data combined suggested that colleges and universities were responsible for about 20 percent of the research of the nation. In *Science and Public Policy* it is estimated that universities spent 12 percent of the national total for research and development in the physical and biological sciences in 1930, 9 percent in 1940, 2 percent in the 1941-1945 period, and a little less than 4 percent in 1947.

Science the Endless Frontier estimates that before the war pure research accounted for 70 percent of the research expenditures of colleges, universities, and endowed research institutes, but for only 5 percent of the research budget of industry and 15 percent of governmental research expenditures. The ratio of total expenditures for pure science to those for applied science was 1 to 6. The comparable ratio for England was estimated at 1 to 1.2. The 1947 figures for research and development (in the physical and biological sciences, excluding atomic research) given in *Science and Public Policy* show less than 10 percent of the national total going for basic research. Industry spent 2 percent of its total for basic research, the federal government 9 percent, and the universities 78 percent. The recent increases in expenditures have clearly been for applied research and development and not for fundamental investigations. Basic research has suffered relatively and absolutely, because of the pressure on personnel to work in the applied field. The obvious place to seek to improve the ratio is in the colleges and universities and endowed research institutes, since they already devote so considerable a proportion of their research efforts to basic inquiries.

These figures do not include social science research. Since it has never had the financial support made available to the natural sciences, its inclusion could only add force to the conclusion that college and university research facilities cannot satisfactorily meet the increasing demands being made on them. With industry just beginning to see the possibilities of social science research and the obvious need of government agencies on all levels for greater basic knowledge in the social sciences, the discrepancy between what is

done and what should be done in college and university research becomes even greater.

TRAINING RESEARCH PERSONNEL

Before the war there were indications that the research training facilities of the country could not supply the then existing needs. On the basis of available information with regard to the percentage of Ph. D.'s who remained in research work, and the replacements needed to continue the current number of research workers, Dr. Hughes estimated in 1938 that the supply of well-trained research workers was considerably below the demand. The refusal of the Armed Services during the war to give consideration to the need for a continuing and increasing supply of scientifically trained minds has made the situation critical. *Science the Endless Frontier* describes a deficit of 150,000 science and technology students who would have received bachelor's degrees except for the war and a further deficit of those obtaining advanced degrees in these fields which will amount to about 17,000 in 1955. The *Science and Public Policy* estimates take into consideration the large numbers of degree holders who do not go into research, and place the net "loss" of research workers at 40,000. If the social scientists were included, the totals would be much greater.[6] The shortage in number of scientists will be greatly decreased by the students now in college; about 80 percent more were majoring in science in 1947 than were in the fall of 1941. At the same time, however, the number of professors increased only 20 percent and the proportion of science teachers with doctorates was less than just before the war. Under these conditions it is inevitable that the quality of the training given should deteriorate.

REGIONAL DISTRIBUTION OF UNIVERSITY RESEARCH

If the support and encouragement of fundamental research and training for research are rightly matters of national concern and merit the use of large public funds, as recommended by the two Presidents' committees which have studied the subject, the geo-

[6] In this connection attention should be directed to the recently published monograph by Elbridge Sibley, *The Recruitment, Selection, and Training of Social Scientists* (New York: Social Science Research Council, 1948. Bulletin 58). The present study was already in proof when Dr. Sibley's monograph was released.

graphical distribution of existing facilities and of proposed expansions is a matter of considerable importance. The range of the influence of a research institution cannot be measured in miles, and the effective use of all research facilities is in part dependent upon the interactions which result from centralization of many different kinds of research activities. Nevertheless, areas in which research institutions operate receive benefits greater than those which accrue to the world at large. This more immediate influence can be observed in greater appreciation for and use of research findings and in the recruitment and training of research talent, as well as in specific applications resulting from research on local materials and problems.

Most college and university research is at present concentrated in a relatively small number of institutions which are located in those regions which are responsible for most of the industrial research of the nation. They are also the regions where wealth, population, and industry are concentrated. It is perhaps inevitable that research should have developed in this way, and the situation should not be too hastily deplored. The advantages to the nation of the centralization of talent and facilities have been great. If, however, there is to be stock taking and planning for future expansion, the total situation needs to be examined and evaluated, and the needs of other sections of the country considered. If new research centers are to be encouraged, it might well be that the national welfare calls for their location in areas now without such institutions.

Present concentration can be demonstrated by a variety of measures. When the American Council on Education made its study of graduate schools in 1934, there were 11 universities with five or more departments which were considered distinguished. In 1934-1937, and again in 1939-1942, 50 percent of the doctoral dissertations in research fields were accepted by 11 universities, 8 of them on the previous list. All except one of the 10 institutions which spent more than $1,500,000 annually on research in the thirties were on the list considered superior in 1934. Half of the men starred in the 1938 *American Men of Science* who were located in colleges and universities were on the faculties of 9 institutions, and all of these are included in the first list referred to above. In addition, there is some evidence that superior under-

graduate training for research is similarly concentrated. Nine institutions provided the undergraduate training of 50 percent of the men who were starred in *American Men of Science* from 1933 to 1943, 7 of them from the first list cited above.

The concentration of research facilities and personnel in a relatively small number of institutions was accentuated during the war. The pressure for quick results led to use and expansion of the already established and successful laboratories. The large research centers got new equipment and grew larger at the expense of the science staffs of other colleges and universities.

The top-ranking institutions are concentrated in the Northeast and the Middle States regions and the state of California, most of them in a sweeping semi-circular band stretching from Massachusetts to Minnesota. The Southeast, the Southwest, and the Northwest are not represented in the list. There are thus great differences in the degree to which different parts of the country are provided with first-class research institutions to study their resources and problems, to provide training for their talented youth, and to supply trained men and women to meet their applied science needs. To the extent that the influence of a research institution is lessened as its distance increases, some regions of the country are seriously disadvantaged, and the welfare of the whole thereby affected, while others have the research influence multiplied by many institutions of high caliber.

WEAKNESS IN A CRUCIAL SPOT

With the almost staggering tasks ahead of meeting the needs for fundamental research and the demands for greater numbers of trained workers, the research facilities of the colleges and universities of the country can be judged only as pitifully inadequate. First in importance because of the fundamental character of their contributions to research, they are last in expenditures and last in organization and planning. The research superstructure has been increasing beyond the capacity of the base to support it, a condition which cannot continue indefinitely. Even the most essential element of strength of the university research structure, the superior research mind, was turned to other fields by the demands of war, and the relative financial weakness of the school as compared with

the industrial corporation has resulted in the permanent loss of many able scientists.

That the problem is national in scope and demands immediate attention has been ably presented by the two committees which have reported to the President on the situation in the natural sciences. It is highly desirable that a similar case be made for the needs in the social sciences, even though the desirability of government support may be more debatable. Imbalance between these two broad fields may be in the end more serious than that between pure and applied research in the natural sciences. Additional support for college and university research must be found, whether from the federal government, as recommended, or elsewhere. There is also need for more careful planning and organization of research within the institutions, and particularly more economical use of highly trained research personnel. Universities spend much less for various aids to research per dollar of salary than does industry, with a resulting waste of talent and skill.

Indicative of the general failure to provide facilities to make possible the most effective use of research talent is the condition of libraries. In 1938 Dr. Hughes made the following summary:

> Eight of the great universities have libraries adequate in all fields, and staffs competent to give the best service. They are each spending $300,000 to $600,000 a year on their libraries. Ten more, each spending from $100,000 to $200,000 have libraries excellent in certain fields and fully competent staffs and are building fine library services. About 10 others, while at present less well served, are spending as much and are well on the way toward libraries adequate to their needs. A few score colleges have libraries fully adequate for their needs as undergraduate colleges. Beyond this it can scarcely be said that libraries approach what is desirable in view of the work attempted by the various institutions.[7]

UNIVERSITY RESEARCH IN THE SOUTH

THE SOUTH NEEDS UNIVERSITY RESEARCH

The southern regions of the United States should have the services performed by universities which function as research centers. Knowledge is needed about the natural resources, material of economic well-being; about human resources, chief im-

[7] National Resources Committee, *op. cit.*, p. 179.

pediment and greatest promise of the region; about the processes whereby all the resources can be employed; about the means of achieving sound regional development within the framework of the nation and the world. Skilled people are needed to fill technical jobs in old and new industrial plants, to meet, through study and practice, the technical problems of production and marketing of agricultural products, to provide governmental agencies at all levels with competent staffs, and, above all, to discover new means of bringing knowledge to the people as a whole and of assisting them to develop cooperative means of helping each other to the end of maximum development of individual ability and optimum social returns from energy expenditure.

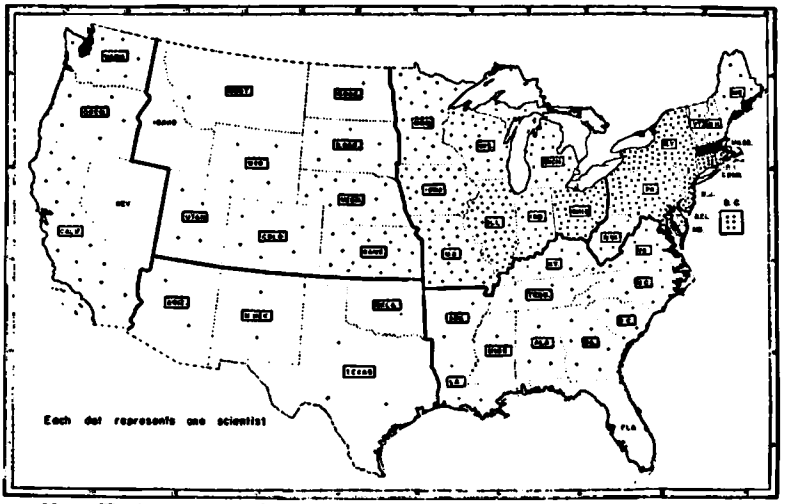
Interest in better training for the young people of the South is a matter of national concern because of the region's high birth rate and its consequent disproportionate contribution to the future population of the country. For the South itself the provision of training facilities will make the difference between utilization and waste of much talent; it may also make the difference between retention and complete loss of its most able young people. The training must be of a superior order and oriented to the future, insofar as it can be foreseen. Opportunities to use the resulting skill must also be provided, but they cannot come until the skill exists; their development depends upon men with initiative and an interest in the region, plus the trained intelligence to implement these.

NO GREAT UNIVERSITY RESEARCH CENTERS

Measured against requirements, the college and university research resources of the South are meager. No one of the top ranking universities of the country is located in the Southeast or the Southwest. Only four southern universities are members of the Association of American Universities. The technical schools in the South are not on a level with those of other regions in number or resources.

This lack of superior institutions has results which bear directly upon regional welfare and development. Southern young people who want the best available scientific training must leave their regions, and the tendency is for many of them not to return. This

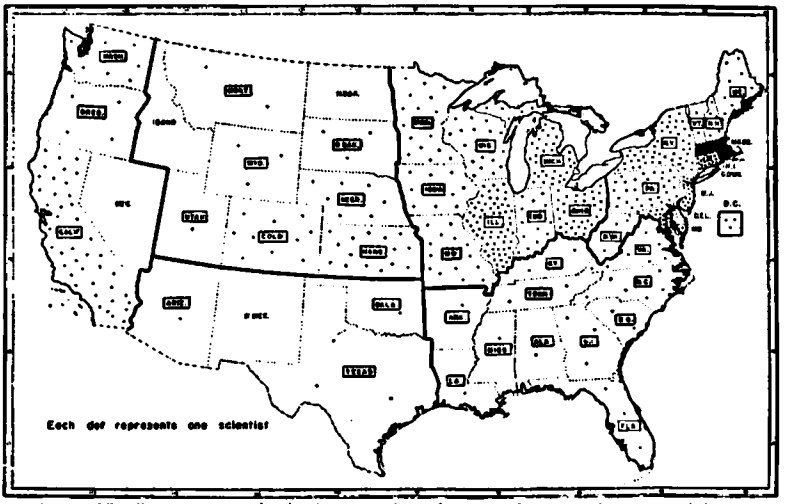
Figure 4. THE YOUNGER STARRED SCIENTISTS LOCATED BY STATE OF BIRTH



Note: The "younger starred scientists" are those first starred in *American Men of Science* in the 1927, 1933, and 1938 editions.

Source: S. S. Visher, "Distribution of the Younger Starred Scientists," *American Journal of Science*, 237 (January, 1939), Table 1, p. 52.

Figure 5. THE YOUNGER STARRED SCIENTISTS LOCATED BY STATE IN WHICH UNDERGRADUATE DEGREE WAS GRANTED



Note: The "younger starred scientists" are those first starred in *American Men of Science* in the 1927, 1933, and 1938 editions.

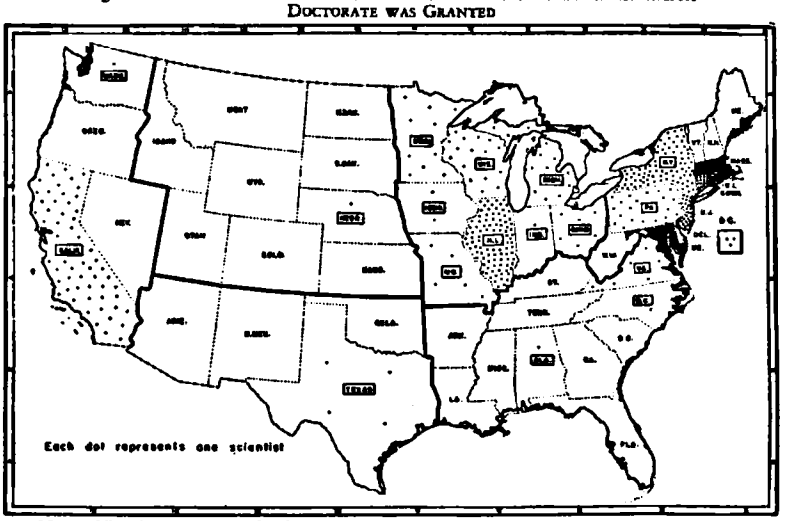
Source: S. S. Visher, "Distribution of the Younger Starred Scientists," *American Journal of Science*, 237 (January, 1939), Table 1, p. 52.

situation is illustrated by the accompanying series of maps (Figures 4-11), based on an analysis of biographical data for the group of natural scientists who were first starred in the 1927, 1933, and 1938 editions of *American Men of Science,* and the social scientists who received postdoctoral research training fellowships from the Social Science Research Council during the period 1925-1939. The "drag" of talent out of the South was more completely analyzed by Dr. Wilson Gee in 1932 in his *Research Barriers in the South;* the present data serve chiefly to indicate that conditions have not changed.

These maps show clearly the tendency for training at the higher levels to be concentrated in a few centers and for other parts of the country to send more people to these training centers than return. The number of starred Men of Science varies slightly from map to map because complete data on place of birth, place of training, and occupational location are not available for every individual and because foreign birth, training and location cannot be shown. The social scientists for whom complete data could not be shown were omitted, so that the same individuals are indicated on each map of the second series. The Fellows excluded were 30 born in foreign countries and 5 who received their training outside the United States. These two groups represent the highest level of research talent, one in the natural sciences and one in the social sciences. In both cases it is evident that the Southeast and the Southwest do not contribute what they should in the way of talent or training, and that they do not share in the benefits that come from the presence of superior scientists at work on their problems.

Eventual location is not necessarily related to the place of graduate training, but the interrelatedness of many different aspects of the research "complex" in our society makes it likely that the same areas have the great research training institutions and the most remunerative and intellectually stimulating employment opportunities for the person interested in research. Few good research men will go where they know the research facilities are inferior, and those who begin in such an unfavorable location tend to leave at the first opportunity. In fields of study in which local materials provide the subjects of investigations, inquiries of special interest to the South are not attacked by the top research minds. To the extent that private corporations and public organizations

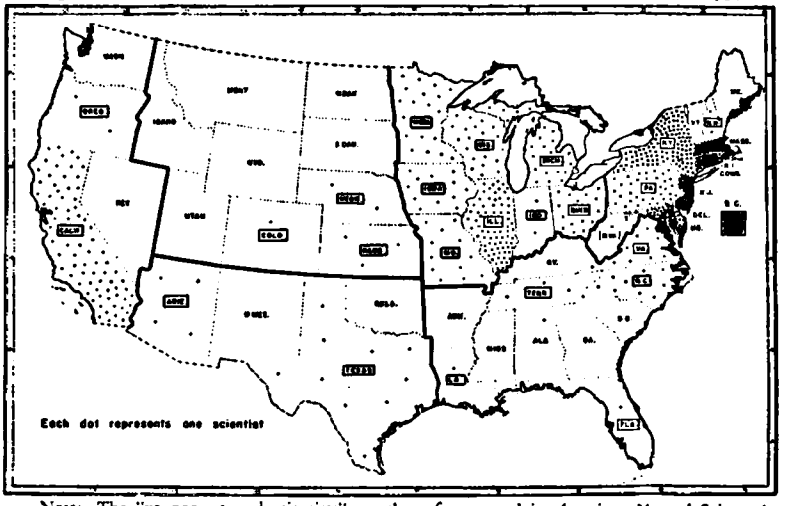
Figure 6. THE YOUNGER STARRED SCIENTISTS LOCATED BY STATE IN WHICH DOCTORATE WAS GRANTED



Note: The "younger starred scientists" are those first starred in *American Men of Science* in the 1927, 1933, and 1938 editions.

Source: S. S. Visher, "Distribution of the Younger Starred Scientists," *American Journal of Science*, 237 (January, 1939), Table 1, p. 52.

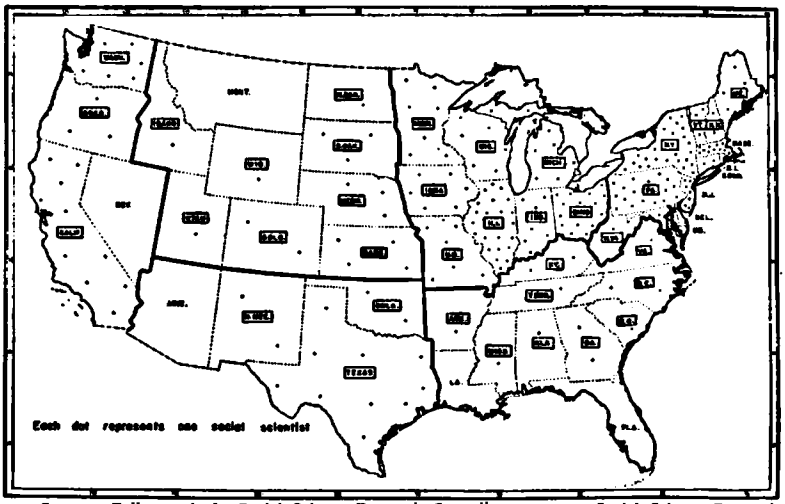
Figure 7. THE YOUNGER STARRED SCIENTISTS LOCATED BY STATE OF RESIDENCE IN 1938



Note: The "younger starred scientists" are those first starred in *American Men of Science* in the 1927, 1933, and 1938 editions.

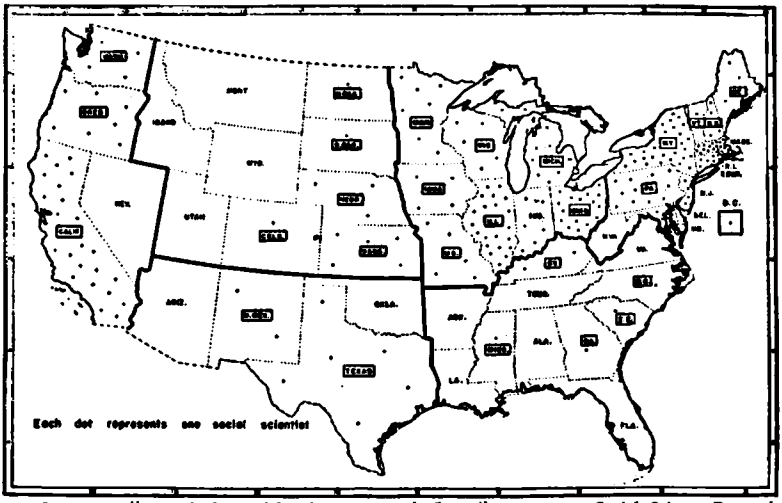
Source: S. S. Visher, "Distribution of the Younger Starred Scientists," *American Journal of Science*, 237 (January, 1939), Table 1, p. 52.

Figure 8. Social Science Research Council Postdoctoral Fellows, 1925-1939, Located by State of Birth



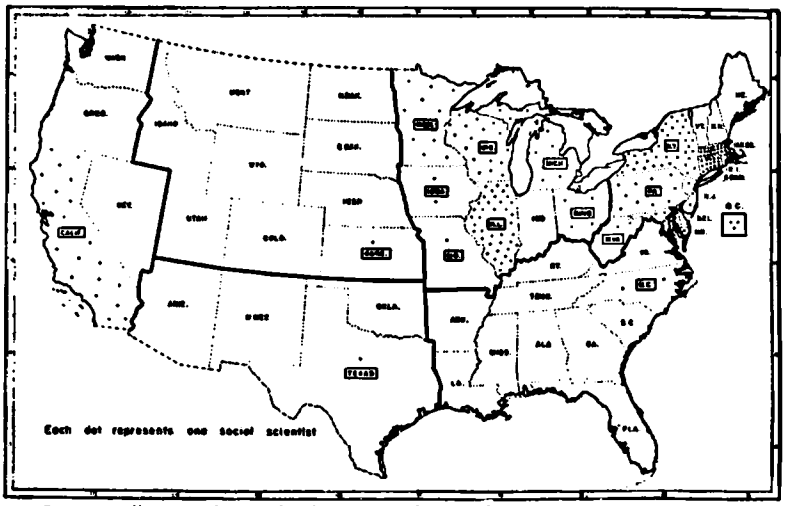
Source: *Fellows of the Social Science Research Council, 1925-1939,* Social Science Research Council, 1939.

Figure 9. Social Science Research Council Postdoctoral Fellows, 1925-1939, Located by State in which Undergraduate Training was Received



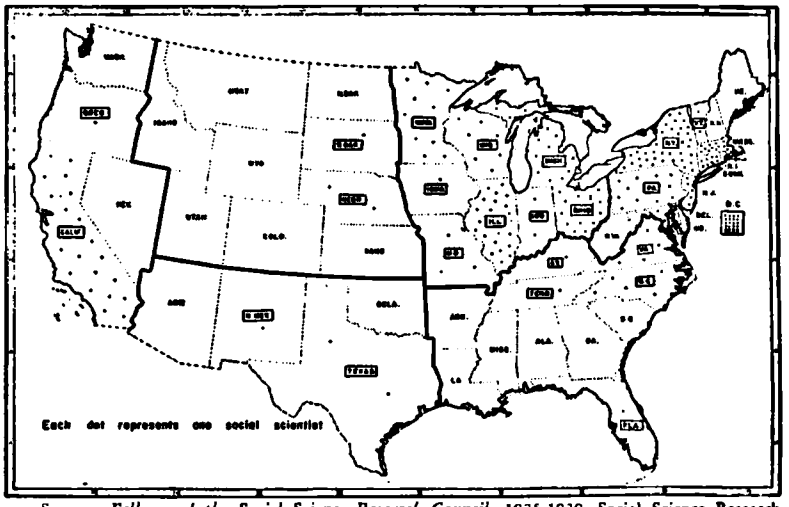
Source: *Fellows of the Social Science Research Council, 1925-1939,* Social Science Research Council, 1939.

Figure 10. Social Science Research Council Postdoctoral Fellows, 1925-1939, Located by State in which Graduate Training was Received



Source: *Fellows of the Social Science Research Council, 1925-1939*, Social Science Research Council, 1939.

Figure 11. Social Science Research Council Postdoctoral Fellows, 1925-1939, Located by State of Employment, 1939



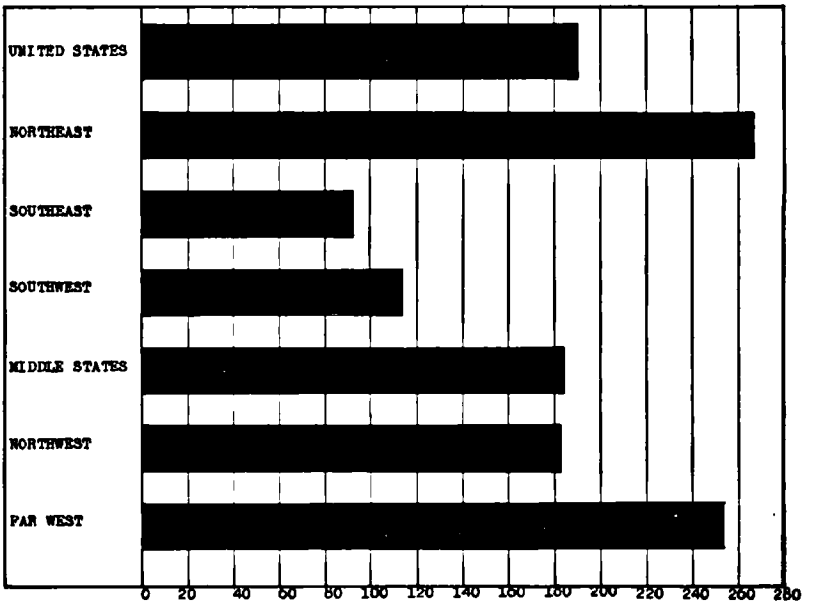
Source: *Fellows of the Social Science Research Council, 1925-1939*, Social Science Research Council, 1939.

benefit from contact with research scientists, southern industry and southern organizations, including local and state governments, must content themselves with less able advice and assistance than that available in other regions. In 1938 the Southeast and Southwest had fewer of the total list of men in *American Men of Science* in proportion to population than other regions (Figure 12). An analysis of the employment locations of members of the American Chemical Society gives further evidence:

> . . . nearly 60 percent of the membership in each of the 9 years in the period 1926 to 1941 were located in the Middle Atlantic States and the East North Central Region.[8]

It is of interest that the South Atlantic Region has shown a small

Figure 12. AMERICAN MEN OF SCIENCE, 1938, PER MILLION POPULATION, 1937, BY REGIONS



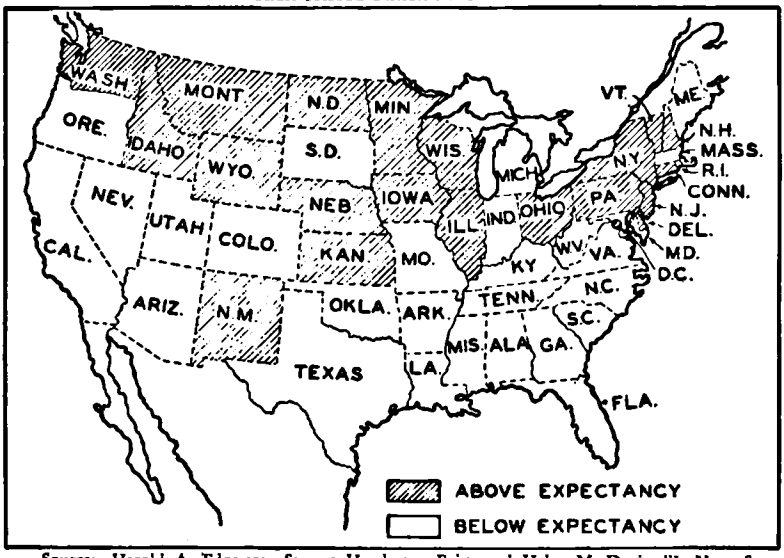
Source: "Men of Science" from E. L. Thorndike, "The Production, Retention and Attraction of American Men of Science," *Science*, 92, 2381 (August 16, 1940), pp. 137-141. Population from *Statistical Abstract of the United States, 1941*, Table 12, p. 10. The 1937 figures are used to approximate as closely as possible the date of selection for the 1938 edition of *American Men of Science*.

[8] Andrew Fraser, Jr., *The Economic Status of the Members of the American Chemical Society*. Reprint combining articles from *Chemical and Engineering News*, 20 (1942), Nos. 20, 22, 23, 24, p. 6.

increase in its proportion of the Chemical Society members over the period covered by the study.

However, the greatest loss to the region without good research training is not the talent which emigrates but that which remains undeveloped through lack of opportunity. Only a small number of southern boys and girls can go to Harvard or Chicago or California or some other distant and therefore more expensive university. Without the stimulation to colleges and secondary schools which emanates from research centers, large numbers may never receive the original impetus to scientific study. For a region which produces more than its proportionate number of young people to be without the influence of great educational institutions constitutes a national as well as a regional loss of the most valuable resource—human skill.

Figure 13. Honorable Mentions (Averages of First, Second, and Third Science Talent Searches) from Each State Above and Below Expectancy Based on High School Senior Population

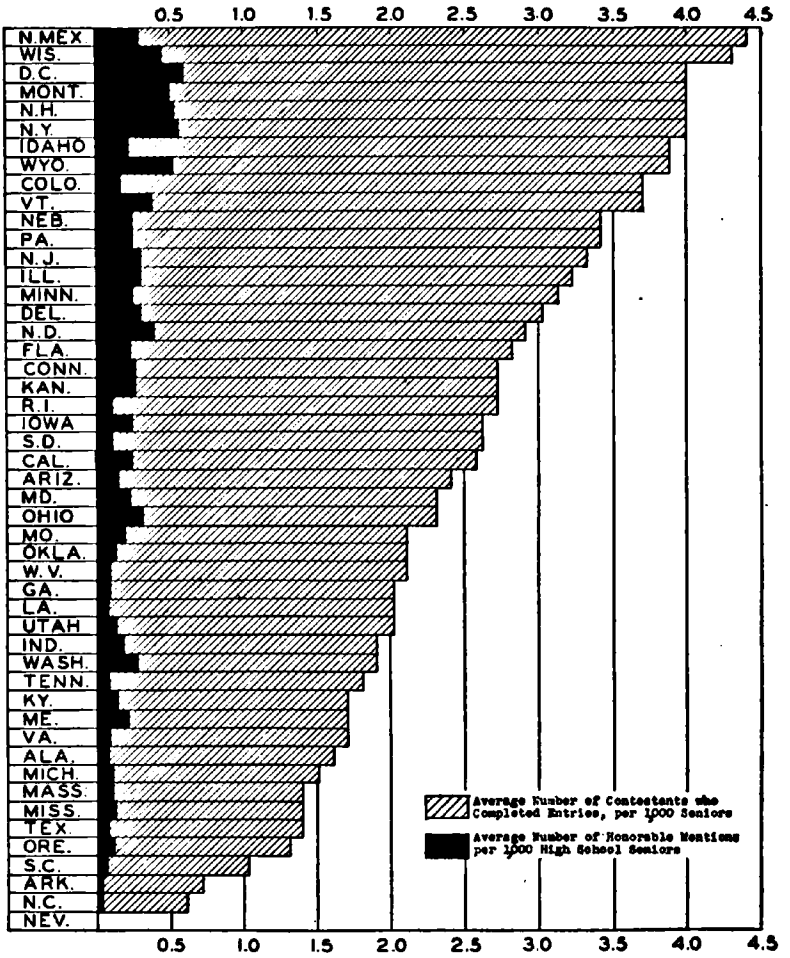


Source: Harold A. Edgerton, Steuart Henderson Britt, and Helen M. Davis, "Is Your State Discovering Its Science Talent?" Reprinted from *Science Education*, 28, No. 4 (October, 1944).

That the secondary schools of the South need the influence of university research centers seems unquestionable. There has been great progress in public education in these regions, but much re-

mains to be done, particularly in scientific fields. The stimulation of research centers could be especially effective. The lack of interest or of preparation in science of southern high school seniors is indicated in Figures 13 and 14 which present data on the con-

Figure 14. States Ranked by Average Number of Contestants per 1,000 High School Seniors in First Three Science Talent Searches



Source: Harold A. Edgerton, Steuart Henderson Britt, and Helen M. Davis, "Is Your State Discovering Its Science Talent?" Reprinted from *Science Education*, 28, No. 4 (October, 1944).

testants in the nation-wide Science Talent Search conducted by the Science Clubs of America. On the whole, the interest evidenced is probably more important than the winning of scholarships.

> In Wisconsin and North Carolina, each of which had approximately 35,000 high school seniors in 1940, theoretically there should be equal chances in the Science Talent Search. But in Wisconsin there has been a total of 1,402 requests for the three years for entrance materials, and 433 seniors have actually filled out the materials completely; whereas in North Carolina there have been only 758 requests in the entire three years, and only 70 seniors have completed entries. The results are significant: Wisconsin has had 45 Honorable Mentions and 9 trip winners; North Carolina has had only 2 Honorable Mentions and no trip winners.[9]

The smaller percentage of completed entrance materials in relation to requests for North Carolina suggests that inadequate preparation as well as lack of interest may be involved. Concurrently with the 1947 Science Talent Search, five southeastern states (Alabama, Georgia, Louisiana, Tennessee, and Virginia) conducted state searches to encourage participation by science students in the national program.

The quality of secondary school education, in its turn, affects the level of work which can be done in colleges and universities. There is no part of the educational system which can be neglected without an effect on other parts. Likewise, improvement at any point will have widespread effects. Insofar as the question is where to concentrate efforts, it can be pointed out that the quality of education depends on the quality of teachers more than anything else. Here methods of selection and working conditions are highly relevant, but training comes first.

TOTAL UNIVERSITY RESEARCH RESOURCES INADEQUATE

The South might meet its research needs without any institution ranking among the few best ones if it had a sufficient number of lesser but still good universities. In order to judge the adequacy of present university research resources, it is therefore necessary to examine regional totals for various measures which serve to indicate research activities and facilities. This information is also

[9] Harold A. Edgerton, Stewart Henderson Britt, and Helen M. Davis, "Is Your State Discovering Its Science Talent?" *Science Education*. 28, No. 4 (October, 1944).

a prerequisite for attempts to increase existing resources, since it shows strengths and weaknesses.

Few First-Rate Graduate Schools

There are 51 southeastern and 13 southwestern colleges and universities and 2 southeastern and 2 southwestern technical schools on the Association of American Universities' list of the institutions which give adequate preparation for the graduate schools of the members of the Association. This is a valuable reservoir of training facilities for undergraduates, but the development of research centers, if it comes, must be expected in the colleges and universities already offering graduate work. The Conference of Deans of Southern Graduate Schools represents 29 institutions in 13 southern states. The Ph. D. degree is offered by 14 of these, the M. A. degree by 25, and the M. S. degree by 24. Professional degrees, in addition to other postgraduate work, are offered by 12.[10] It is in this group of institutions that the college and university research resources of the southern regions are to be found.

There has been no general attempt to rate graduate schools on the quality of their work since the 1934 study of graduate instruction by the American Council on Education. At that time eight southeastern and southwestern institutions were considered to be adequately staffed and equipped to give the doctorate in certain designated fields—Duke University, George Peabody College for Teachers, Rice Institute, and the Universities of Arizona, North Carolina, Oklahoma, Texas, and Virginia. Forty-two departments were listed as "adequate" and two were starred as "distinguished," sociology at the University of North Carolina and genetics at the University of Texas. Two institutions, the University of North Carolina and the University of Texas, had 23 of the 42 "adequate" departments. Since 1934, graduate work has been growing in quantity and quality in southern universities, and additions would certainly be made if an evaluation were attempted now. The four southern members of the American Association of Universities are Duke University, and the Universities of North Carolina, Texas, and Virginia.

[10] Charles W. Pipkin, *Graduate Work in the South*, a paper presented before the Conference of Deans of Southern Graduate Schools at its thirteenth annual meeting held in Atlanta, Georgia, October 27-28, 1939, pp. 8-9.

Because of the research requirements for the doctorate and the requisite research specialists to direct this work, the number of Ph. D. degrees awarded can be used as one index of research activities, although it must be regarded as a partial one. The accompanying series of maps (Figures 15-24) shows the South providing little of this highest level of graduate training in the physical sciences, the biological sciences, the social sciences, and in special subjects—physics, chemistry, engineering, agriculture, economics, political science, and sociology. These maps are based on the Association of Research Libraries' compilations of the doctoral dissertations of a research nature accepted by American universities for three years preceding the full impact of the war on education, 1939-1940, 1940-1941, 1941-1942.[11]

The four southern members of the American Association of Universities granted 60 percent of the doctorates given in the three-year period. These, Duke University and the Universities of North Carolina, Texas, and Virginia, together with George Peabody College and Louisiana State University granted almost 80 percent of the total. The four outstanding universities also awarded 60 percent of the degrees in the ten-year period, 1929-1939. The two institutions granting the next largest numbers over the ten years were Peabody and the Southern Baptist Theological Seminary, with most of their degrees in education and religion, respectively. Next in order were Vanderbilt University, Louisiana State University, and the University of Kentucky. The increase in graduate work at Louisiana is particularly noteworthy when the two periods, 1939-1942 and 1929-1939 are compared. More doctorates were awarded at that institution in the recent three-year period than in the ten years preceding.

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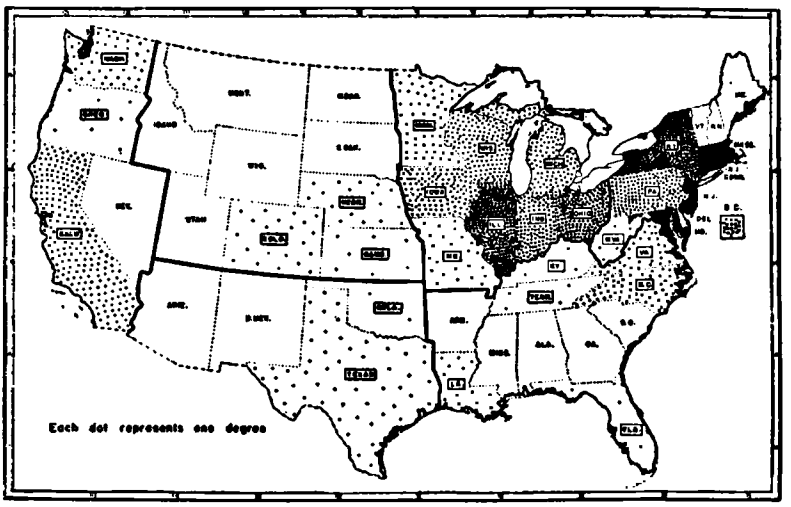
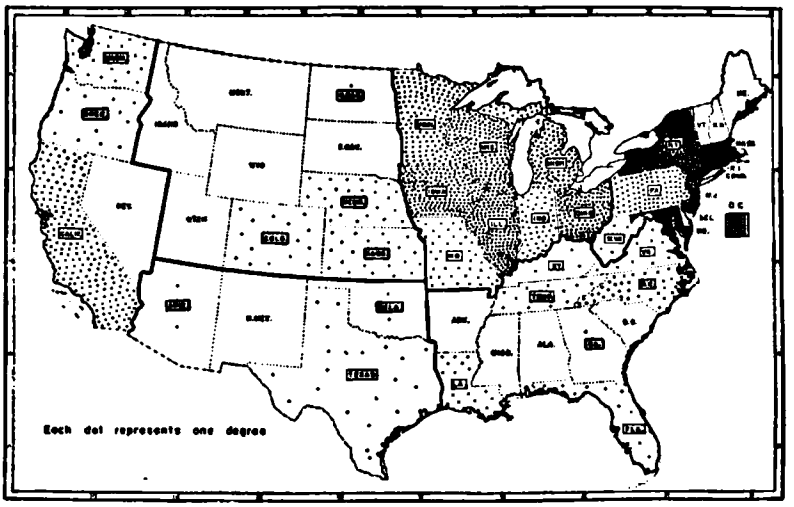
[11] Compilations of doctoral dissertations for longer periods are available in the American Council on Education's *American Universities and Colleges*. Mary Bynum Pierson has detailed lists for southern institutions in her *Graduate Work in the South*. The United States Office of Education also has material on degrees granted by colleges in its *Statistics of Higher Education*. It should be noted that the various sources do not always agree. The tables of the Association of Research Libraries were used here because of their detailed form. As an instance of discrepancy, the Office of Education reports 3 doctor's degrees in agriculture at North Carolina State College, 1 at the Agricultural and Mechanical College of Texas, 1 at the University of Florida, and 1 at Louisiana State University which are not included in the data mapped. Similarly, 5 doctor's degrees in engineering are reported by the Office of Education for North Carolina State College. Mrs. Pierson lists 1 doctorate in animal husbandry at the University of Florida, 1 in agricultural economics and 1 in chemical engineering at Louisiana State University, and 1 in animal husbandry at the Agricultural and Mechanical College of Texas, all of which are missing in the Association of Research Libraries material. These numbers are not large; they should be noted chiefly because they occur in fields in which the South is seriously deficient.

Figure 15. NUMBER OF DOCTORATES GRANTED IN THE PHYSICAL SCIENCES, 1939-1942, BY STATES



Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 16. NUMBER OF DOCTORATES GRANTED IN THE BIOLOGICAL SCIENCES, 1939-1942, BY STATES



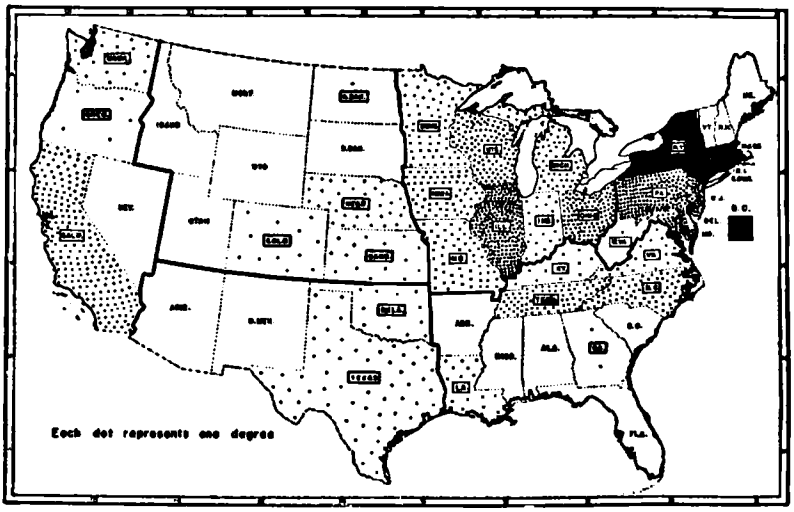
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

The same four universities mentioned above award doctorates in the largest number of different fields, with Peabody and Louisiana next in order. In the case of Peabody it should be noted that the bulk of the degrees are in one subject, education—60 percent for the ten-year period and 79 percent for the more recent three years. At Rice Institute the degrees are all in natural science subjects. The Universities of South Carolina and Tennessee, which awarded a few degrees in the earlier period, do not appear in the later data.

Material on other graduate degrees would add little to this measure of research facilities. There is more variation in the research requirements for the M. A., and it is possible to give the degree with a less adequate staff and less equipment than is true of the doctorate. The number of M. A. and M. S. degrees given by southern institutions is more than ten times the number of doctorates and, as has been indicated, more institutions are included. In some of the professional fields where graduate work has been developing only recently, science degrees at the lower level perhaps have more research significance than the M. A. in other subjects, but substantial efforts by universities to build up research usually include plans for training at the more advanced level. The use of doctorates to indicate research activities is not intended to suggest that they are completely adequate measures. They serve only as an available index usually associated with other phases of research and research training.

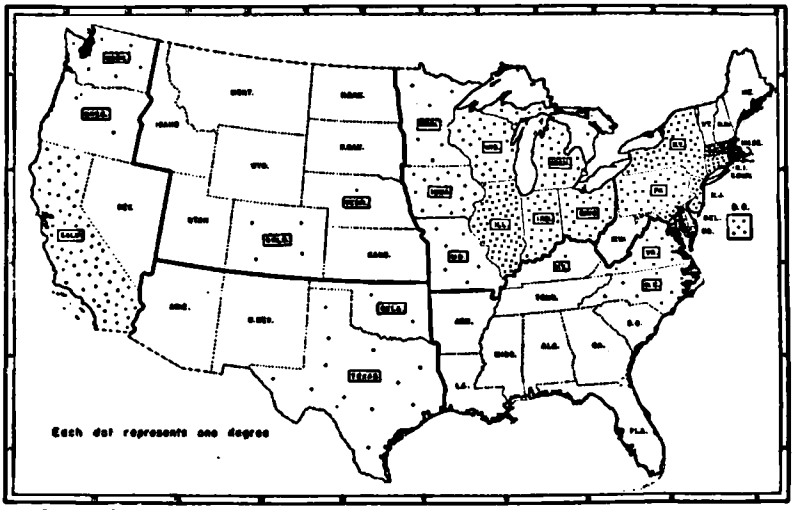
Research may also be associated with undergraduate training, and faculty members in undergraduate colleges make valuable contributions to scientific knowledge. Through study of the degrees granted or any other usually reported items, it is not possible to discover the institutions at which this is the case. The importance of these research activities should not be minimized, but it is nevertheless true that the bulk of research resources in institutions of higher learning is found in those colleges and universities with organized research and graduate programs. This is necessarily the case because of the heavy teaching schedules in all but the most wealthy undergraduate colleges, the difficulties of conducting research without extensive library, laboratory, and other aids, and the tendency of superior research men and women to seek their work in institutions where research is facilitated. The

Figure 17. NUMBER OF DOCTORATES GRANTED IN THE SOCIAL SCIENCES, 1939-1942, BY STATES



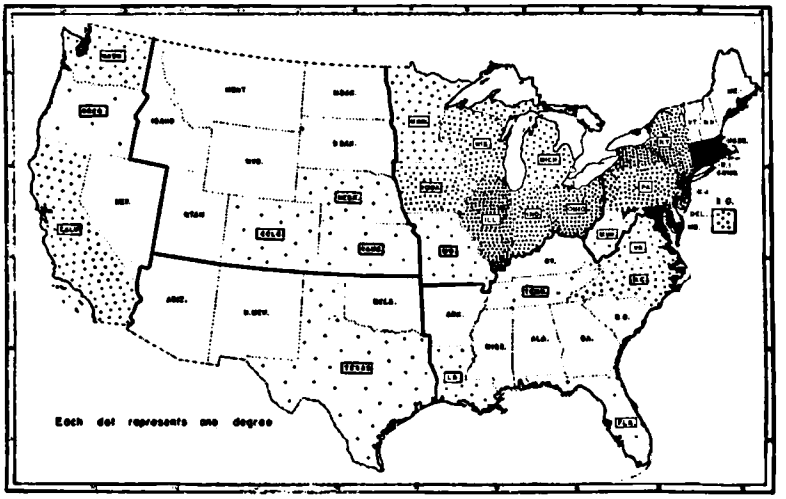
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 18. NUMBER OF DOCTORATES GRANTED IN PHYSICS, 1939-1942, BY STATES



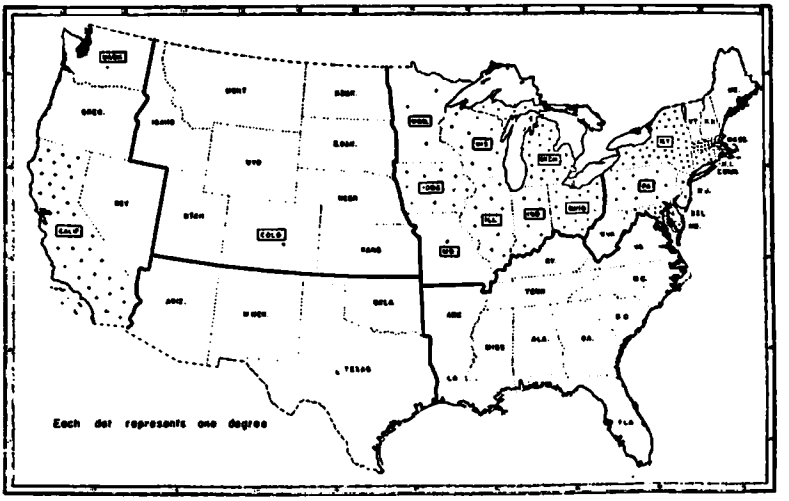
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 19. NUMBER OF DOCTORATES GRANTED IN CHEMISTRY, 1939-1942, BY STATES



Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 20. NUMBER OF DOCTORATES GRANTED IN ENGINEERING, 1939-1942, BY STATES



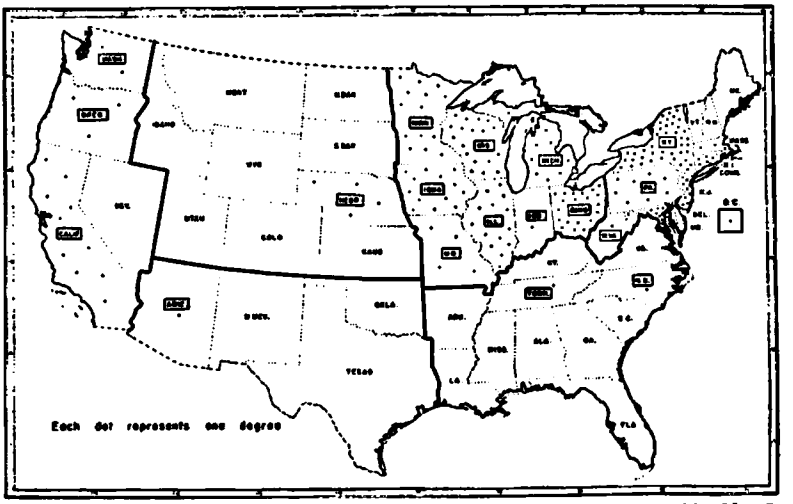
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

important contribution to research of the undergraduate college is the stimulation of able students to continue scientific study on the graduate level. Data provided by the Office of Scientific Personnel of the National Research Council and presented in volume four of *Science and Public Policy* indicate that many of these institutions are effective in performing this function. Of the 44 institutions which rank highest in the number of successful science Ph. D. candidates per thousand students, 39 are colleges, 3 are universities, and 2 are technical schools. California Institute of Technology ranks first with 130 science Ph. D.'s per 1,000 students, but the second place goes to Haverford College with 103, and the third to Oberlin College with 92. No southern institution is in the first ten, which are the only ones identified.

Special Inadequacy in Science

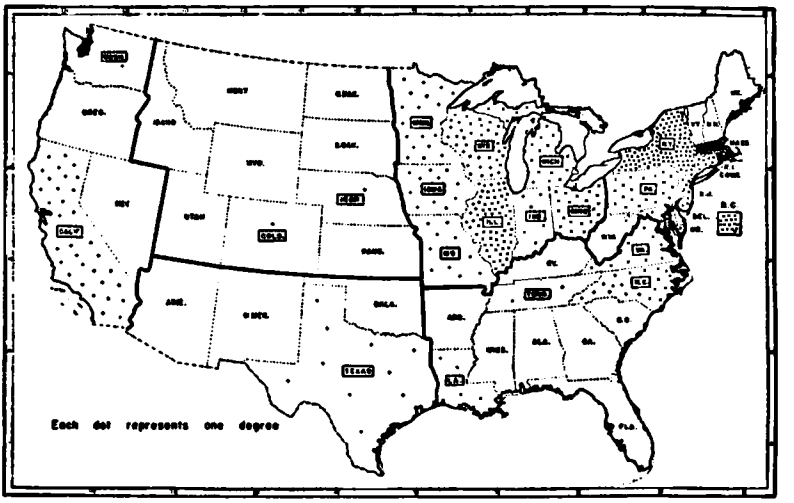
Examination of the detailed classifications of graduate degrees shows relative strengths and weaknesses among subjects and among institutions. The natural sciences are less frequently represented in the graduate training of the South than the social sciences, literature and art, philosophy and religion. The subjects in which the largest numbers of degrees are given by southern institutions are education, chemistry, history, English studies, and religion, followed by physics, psychology, economics, and zoology. In the American Council report, departments of history, chemistry, psychology, and zoology were designated as "adequate" in southern institutions more frequently than others; sociology, English, mathematics, and education came next. The departments in which graduate work is offered by the largest numbers of southern colleges and universities are physics, chemistry, history, mathematics, economics, English, psychology, sociology, education, and philosophy. Certain subjects missing from these lists are of particular significance when viewed in the light of southern needs, especially agriculture and engineering. Large numbers of doctorates in these fields are not given anywhere, but the special needs in the South merit particular attention to them. One might also wonder why the region which produced a Jefferson does not have superior training in political science. Other unstressed subjects which have been cited as vital to the South are animal and human nutrition, bacteri--

Figure 21. Number of Doctorates Granted in Agriculture, 1939-1942, by States



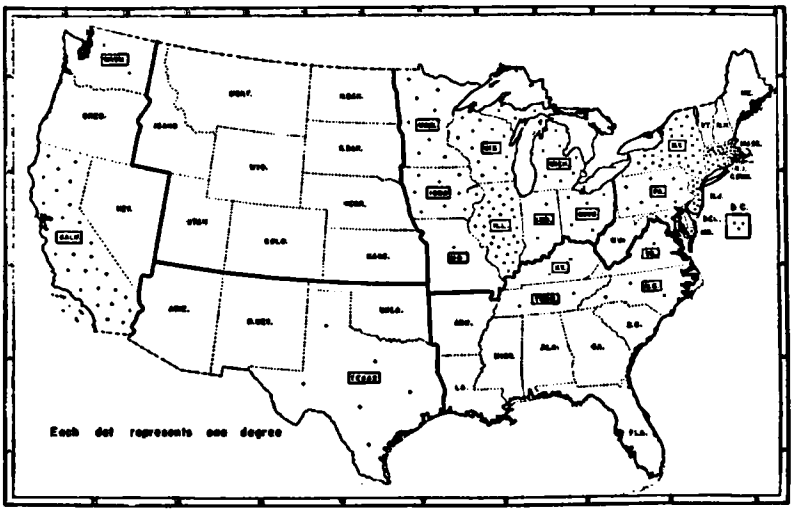
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 22. Number of Doctorates Granted in Economics, 1939-1942, by States



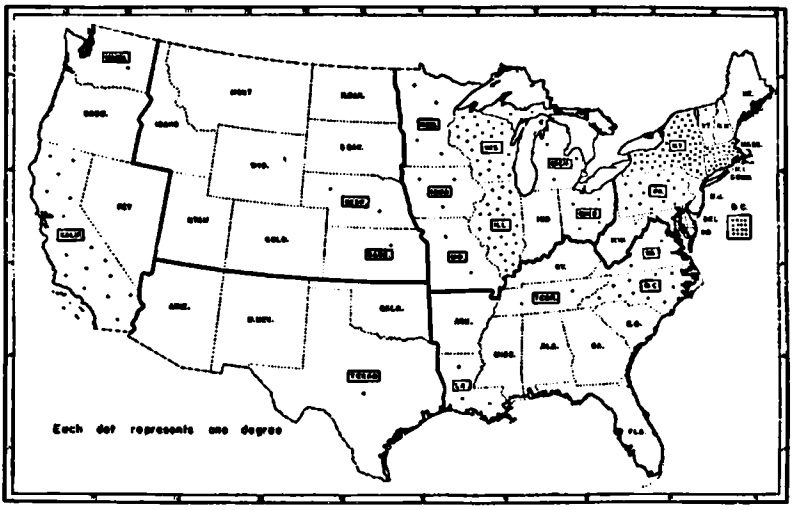
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 23. NUMBER OF DOCTORATES GRANTED IN POLITICAL SCIENCE, 1939-1942, BY STATES



Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

Figure 24. NUMBER OF DOCTORATES GRANTED IN SOCIOLOGY, 1939-1942, BY STATES



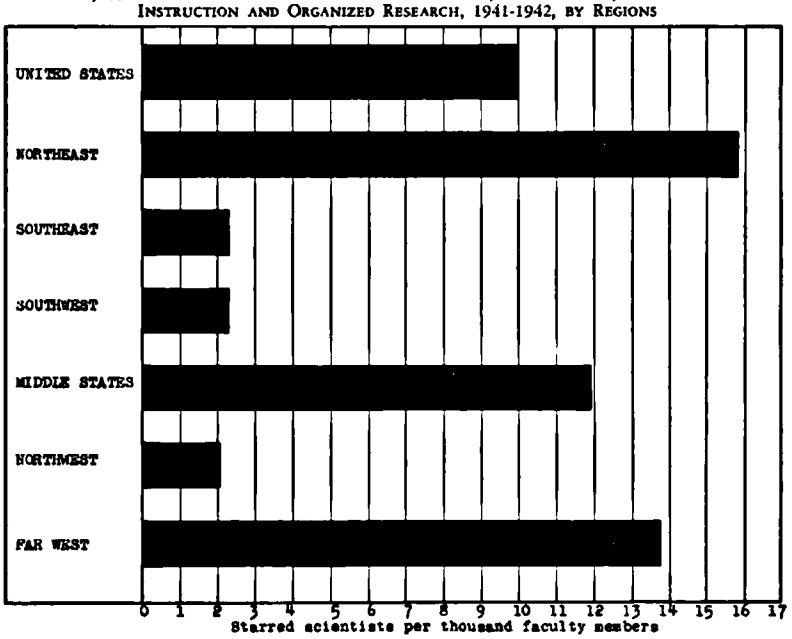
Source: E. A. Henry (ed.), *Doctoral Dissertations Accepted by American Universities*, Nos. 7, 8 and 9 (1939-1940, 1940-1941, and 1941-1942), Table III in each volume.

ology, entomology, geography, plant pathology, plant physiology, and soil science.

Faculty

The most important factor determining the quality of research training, as well as the quality of research performance, is the ability of the men doing the work. The quality of a faculty is not something which can be measured directly, but indicators can be used for broad regional comparisons. The men who are starred in *American Men of Science* can be taken as outstanding in research in the natural sciences. Figure 25 shows for each region

Figure 25. STARRED AMERICAN MEN OF SCIENCE LOCATED IN COLLEGES AND UNIVERSITIES, 1943, PER 1,000 FACULTY MEMBERS ENGAGED IN COLLEGIATE, PROFESSIONAL, AND GRADUATE INSTRUCTION AND ORGANIZED RESEARCH, 1941-1942, BY REGIONS



Source: "Men of Science" from National Resources Committee, *Research—A National Resource, I. Relation of the Federal Government to Research,* Table II, p. 174 and Jacques Cattell, "Scientific Men Receiving Stars in the Seventh Edition of *American Men of Science,*" *Science.* 100, 2589 (August 11, 1944), pp. 127-129. Faculty members from U. S. Office of Education, *Statistics of Higher Education, 1939-40 and 1941-42,* Table 5, pp. 50-51. (In the National Resources Committee source 21 institutions having only one starred man and he 66 years of age or older are not included. In three cases the totals recorded were not the totals of the individual items. In each case the difference was no more than one. The individual items were taken as correct and the totals changed accordingly. In the U. S. Office of Education source the research workers in the agricultural experiment stations were not reported by 3 states, California, Georgia, and Ohio.)

the ratio of the number of these men on college faculties to the total number of faculty members engaged in collegiate, professional, and graduate instruction and organized research. The Southeast has 15 percent of the faculty members, but only 3 to 4 percent of the superior scientists. The Southwest has 6 percent of the faculty members, and only 1 percent of the starred scientists. Each of these southern regions has 2.3 starred men per 1,000 faculty members, while the national figure is 10 per 1,000.

There has been no comparable selection of men who are superior in research outside the natural sciences. It is broadly accurate to assume that emphasis on research in a university includes all fields and that superior natural scientists have as faculty colleagues men superior in other specialties. However, this does not hold true for individual institutions. In some universities the social sciences have not been given the support provided the natural sciences. Research in literature, philosophy, religion, and the arts is less in volume, not so well organized, and more poorly financed than that in the sciences, although special support has been given to these fields by some of the foundations.

Library Facilities

Many types of research are impossible without access to adequate library materials. Moreover, it has been estimated that 10 percent of the time and money cost of all research projects can be saved through proper use of a good library. Therefore planning for research must include library facilities.

The South's lack of total library resources and special library facilities for research has been pointed out clearly by experts in this field. When Dr. L. R. Wilson tabulated volumes in research libraries by states in 1935, the Southeast had six percent of the total, the Southwest two percent. A ranking of 52 of the larger college and university libraries of the country according to number of volumes on July 1, 1943, includes five from the Southeast, one from the Southwest. The University of Texas ranks 13 in the list, Duke University 16, the University of North Carolina 33, the Joint University Libraries (Vanderbilt, Peabody, and Scarritt) 34, the University of Virginia 36, and Louisiana State University

42.[12] This ranking does not take cognizance of the fact that Duke University and the University of North Carolina make joint use of their library resources. The same six southern libraries are members of the Association of Research Libraries. Other libraries in the South which report more than 200,000 volumes are those at Tulane University, the College of William and Mary, the Universities of Alabama, Oklahoma, Tennessee, and Florida, and Emory University.

Southern universities have been and are attempting to remedy their library deficiencies. Their volumes have increased rapidly in recent years. The average number of volumes in the 19 largest university libraries in the South was 23,000 in 1900. In 1943 it was 312,000. In 1917 the University of Virginia was the leading southeastern institution with 80,000 volumes; the University of Texas was the leader in the Southwest with 134,000. In 1943 the leading southeastern institution, Duke University, had 681,000 volumes, and the University of Texas, which still led the Southwest, had 729,000. This expansion is of particular note because it has taken place in spite of limited financial resources. A report compiled by the Princeton University Library in 1938-1939 showed the six southern members of the Association of Research Libraries spending a larger percentage of their universities' total budgets than the comparable percentage for all forty members.

Nevertheless, the regional differential in research library facilities tends to increase.

> Excluding Duke University Library, the fifteen largest university libraries of the southeast region combined have fewer volumes than Harvard. Of the twenty-seven university libraries with more than a half million volumes in America, only one—Duke—is in the Southeast.[13]

It has been estimated that $60,000 a year for new books and periodicals is required in a university center to support Ph. D. work in the major academic fields. In 1942-1943, only two universities in the Southeast and one in the Southwest spent this amount or more.

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[12] Philip G. Davidson and A. F. Kuhlman, *The Development of Library Resources and Graduate Work in the Cooperative University Centers of the South* (Nashville: Joint University Libraries, 1944), p. 10 and Appendix II.

[13] Philip G. Davidson and A. F. Kuhlman, *ibid.*, p. 10.

The total number of volumes in a library is less important for research workers than the completeness of holdings in special fields, but data on such collections are more difficult to secure. In 1942, the Board on Resources of American Libraries of the American Library Association attempted to locate the leading collections for advanced study and research in various fields by collecting the judgments of authorities about the libraries with the best collections. Out of a total of 1,352 collections mentioned, 71 were in the Southeast and 33 in the Southwest. All of the southern holdings listed were in libraries of colleges and universities except for two in theological seminaries. In the whole nation, college and university libraries (including institutes giving advanced technical training) accounted for 63 percent of the collections listed. Duke University and the Universities of North Carolina and Texas had the largest numbers of collections in the South, with Louisiana State University, the Joint University Libraries at Nashville, the University of Virginia, and Rice Institute following. The percentage of social science collections in the southeastern libraries was greater than the comparable percentage for all the libraries included, but more than half of these collections dealt with one subject, the Negro. The southwestern libraries were relatively strong in science collections. Of the 76 specific subjects listed under the general headings, there were 27 in which no southern library had a leading collection.

In an earlier study of southern libraries, R. B. Downs analyzed holdings in specialized subjects and listed the southern schools with the strongest collections in a number of different fields. He noted deficiencies of particular interest, such as the fact that there was no extensive textile collection in the area, the one at Clemson Agricultural College probably being the strongest. In bibliographical material, of the greatest importance to the research worker, he found the Universities of North Carolina and Texas, Duke University, Rice Institute, and Louisiana State University the best equipped in the South. In 1935, Dr. L. R. Wilson found southern collections "particularly deficient in bibliographical apparatus for the use of scholars and in their holdings in such particular subjects as electrical engineering, soil science, plant pathology, and animal husbandry." That progress has been made since 1935 is indicated by the fact that, in the 1942 study, Duke

University is cited as having a leading collection in soil science. Special efforts have been made recently to build up manuscript and original source materials in southern university libraries, especially at the Universities of North Carolina, Texas, and Virginia, and at Louisiana State University. Mrs. Pierson describes some of the more important collections in her account of graduate work in the South.

Recognizing that special procedures are necessary to make the most effective use of available resources, cooperative programs of joint library service have been instituted by a number of universities and colleges. Five centers are now in operation: Duke University and the University of North Carolina; Vanderbilt University, George Peabody College, and Scarritt College; Tulane University, Newcomb College, and the Howard Memorial Library, with some cooperation from Louisiana State University, the New Orleans Public Library and the Shreveport Memorial Library; the University Center of Georgia, including the University of Georgia, the Georgia School of Technology, Emory University, Agnes Scott College, and the High Museum and School of Art; and the Atlanta University System, including Atlanta University, Morehouse College, Spelman College, Morris Brown College, Clark College, and Gammon Theological Seminary. These programs include cooperation in other fields than library service.

Joint library service is not limited to university and college libraries but may include various other agencies, such as state and municipal libraries and private libraries. A few special collections in technical fields have already been built up by private groups in the South, and these could be integrated with the libraries in university centers to avoid duplication and increase total resources. Examples of such collections are the National Cottonseed Products Association's library on livestock feeding in Dallas, and the petroleum collection in the Tulsa Public Library, the latter largely the result of support from engineers and other technical workers who needed research materials. The Institute of Textile Technology is building a textile library at Charlottesville, Virginia. There are undoubtedly others scattered through the southern regions. The great need is for coordination to increase utility and to promote efficient and economical expansion. In 1935, Dr. Wilson selected 77 library centers of not over 50 miles radius con-

taining 500,000 volumes or more. Only 11 were in the South, but these might well serve as starting points for planning for more adequate research materials.

Graduate Stipends

Graduate fellowships and assistantships give financial aid to students who are candidates for advanced degrees and also provide assistance for departmental and individual research projects. At the same time that the students are securing research training they participate in a larger research program and thus contribute to the most effective use of the talents of research directors. Most students do not have the money to continue, without aid, their training beyond the college level, and the number and size of the fellowships available at an institution influence the number and quality of graduate students, particularly the doctoral candidates.

Southern universities have not been able to give fellowships to graduate students in proportion to the need for this aid. This not only reduces the amount of research training; it also reduces the efficient use of faculty abilities. An able investigator can direct many more inquiries than he can perform himself, especially when performance means carrying out a great many detailed and laborious activities as is often the case with research. The relatively poor fellowships offered by southern institutions permit the most able prospective students to be drawn elsewhere for their graduate training. Thus northern and western universities can have their pick of the superior southern candidates, while southern universities cannot hope to attract the best students from other regions. One southern chemistry department has amassed a large file of letters from fellowship candidates explaining that the university's award is being rejected because of a larger offer from some other place, although the candidate would prefer to remain in the South for his training.

Research fellowships financed by organizations other than the universities concerned help both students and institutions. In general they are given for work at universities where it is felt that the best results, in training and research produced, can be obtained. Thus they serve as one criterion of the excellence of research facilities.

National Research Council fellowships in the natural sciences have been given since 1919 in order "to strengthen the foundations of science in the United States." The Fellows are appointed for study at institutions where adequate laboratories and other facilities exist and experienced investigators are available to guide their work. Between 1919 and 1944 there were 1,315 appointments for study in the natural sciences (excluding medical sciences) at universities and colleges in this country or at research and technical institutions or for study abroad. Of these, 8 were given for work at institutions in the Southeast; 17 for work in the Southwest.

Examination of the institutions where Social Science Research Council Fellows have carried on their advanced study indicates a similar situation in the social sciences. In the five years, 1935-1939, 88 individuals had appointments to field training fellowships. Only one university in the 13 southern states participated in the training of these Fellows. In 1935, 1936, and 1937 the Council made 23 awards to students just beginning graduate study in the social sciences. None of these was for work in a southern institution. Fellowships in agricultural economics and rural sociology were granted to 106 individuals between 1928 and 1933, and not one was used for study in a southeastern or southwestern university. Special fellowships for southern students were provided by the Council between 1929 and 1933, and less than half did their work in southern institutions. There were 59 Fellows, with 2 studying at two different places. Of these, 21 studied in the Northeast, 20 in the Southeast, 16 in the Middle States, 2 in the Southwest, and 2 in the Far West.

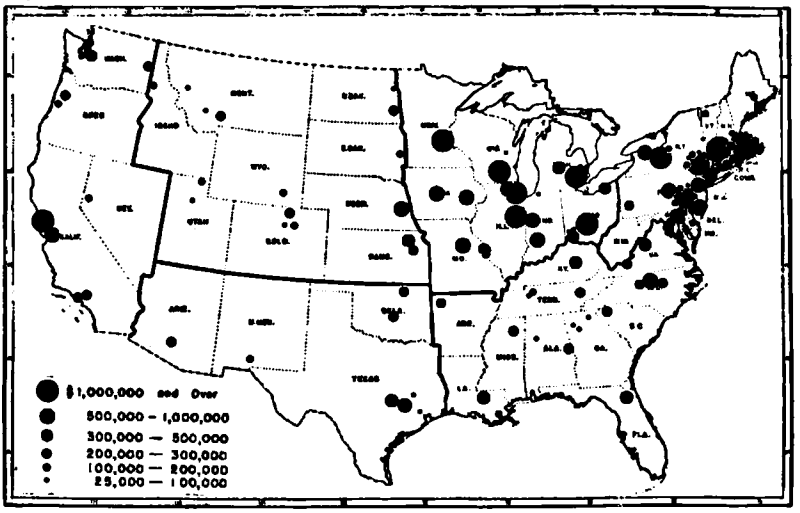
The conditions governing the location of fellowships given by private industry are more varied. Nevertheless, the assumption that the companies want their expenditures to bring maximum returns in training and research findings seems justified. A recent summary of industrial grants shows a total of 956 research fellowships and grants supported by private industry. Of these, 53 are in southeastern universities or agricultural experiment stations, 22 in southwestern ones.

University Research Expenditures

Money alone will not ensure effective research, but it is essential to provide the necessary conditions. All the varied

measures which have been used to show the status of research facilities in southern colleges and universities rest upon the financial support available for research activities. Able men who can conduct and train for research require adequate salaries and working conditions favorable to research. These include library and laboratory facilities and competent assistants. If the South is to have the research of which it stands in such critical need, it must be willing to pay for it. A large part of the explanation for these regions' poor standing in university research resources is to be found in the amount of their expenditures for this purpose. Budgeting and organizational variations make it difficult to secure precise figures for over-all research expenditures, but available information shows the South lagging behind other regions.

Figure 26. Estimated Annual Research Expenditures of 118 Colleges and Universities



Source: National Resources Committee, *Research—A National Resource, I. Relation of the Federal Government to Research* (Washington: Government Printing Office, 1938), pp. 190-191.

In the National Resources Committee study referred to previously, Dr. Hughes made careful estimates of the research expenditures of 118 leading colleges and universities, getting his figures verified by administrative officials wherever possible. Twenty southeastern and eight southwestern institutions were included. These estimates show 14 institutions spending more than $1,000,-

000 annually on research, no one of them in the South. In the 15 which spend between $500,000 and $1,000,000 there is one in the Southeast, Duke University, and one in the Southwest, the Agricultural and Mechanical College of Texas. The Universities of Florida, Kentucky, Texas, and Virginia are listed as spending between $300,000 and $500,000. Figure 26 shows the geographical distribution of the entire list, with the expenditures of various sizes indicated. These figures are now out of date, but they are the most inclusive available. Later estimates have been limited to natural science research. The absolute expenditures in southern universities have certainly increased since these estimates were made. There is more question about improvement in the relative standing of the South.

ADMINISTRATION OF UNIVERSITY RESEARCH

Variety in Research Administration

The administrative organization of southern college and university research programs varies widely. During the period in the latter part of the last century when universities in other parts of the country were expanding their work in scientific training and research, the South was establishing and re-establishing educational institutions after the economic and social chaos of military defeat. The bare essentials of instruction had to come first. As a result, the development of research was greatly delayed, and only now is the South beginning what should be its period of rapid expansion of research.

In some universities the research program originated through the interest and energy of one man with a zeal for seeking knowledge. In others a program started with an administrative attempt to enlarge the sphere of activity and service of the institution or to follow a line of development observed elsewhere. In a few instances research activities were the result of outside pressure, either in the form of a request for research assistance or through an offer of financial support for research. Coming as a relatively late development in the colleges and universities, research had to fit into the already existing institutional structure. In some cases it is still an incidental attachment to the institutional organization rather than an integral part of it. Scattered individuals or depart-

ments conduct investigations; departmental funds may be used for research, but separate accounts are not kept; foundations or industries support inquiries; public agencies ask for and receive research assistance; graduate students conduct research to fulfill requirements for degrees; and there is no definite procedure for handling most of the administrative matters involved in all these activities. In other cases there is clear recognition of the research functions of educational institutions, and administrative machinery has been developed to encourage, support, and control research activities. One may range from institutions with no agencies devoted entirely to research to one which reports 19 separate "organized research" units; from institutions giving no administrative recognition to research activities to the few with committees or councils to represent, supervise, and coordinate all research.

As a consequence, any attempt to describe the organization and administration of college and university research programs runs the risk either of losing its generality in a maze of highly individual and often informal administrative procedures, or of losing its accuracy in an idealized but non-existent schematization. Nevertheless, the administrative organization of university research is an important aspect of its present status. This is particularly true in an area of great deficiency, where it is essential to get the maximum returns from expenditures and where cooperation among institutions and region-wide planning will be necessary to overcome the existing lag.

Increasing Organization of Research

The fields and departments in which research has been long established, such as the medical schools, show less formal organization of research as a separate activity and more individuality in the arrangements whereby research activities are financed and administered. Most investigations are individually planned and conducted. Outside support from foundations and industries is secured by departments or individuals, perhaps with bookkeeping oversight by the business office of the university.

In recent years, and particularly in fields where research is relatively new, there has been a tendency to establish agencies devoted exclusively to research activities. Some of these have

made outstanding contributions. Others have started with great promise but failed to live up to expectations because of personnel or financial difficulties. Some agencies have been financed in large part by philanthropic foundations, and their existence and achievements reflect the interest of the individuals who organized them and arranged the support, rather than general institutional interest in research. The possibility of outside support has been a strong incentive to organization, since a better case can often be made for the successful conclusion of proposed inquiries when there is a definite agency responsible for administration. The number of agencies suggests that formal organization, with its definite and continuing arrangements for time assigned to research, for assistance, and for financial support, contributes directly to the success of a research program.

In most cases these research agencies are separate units within the administrative structure of the institution, with their own advisory or administrative boards. The separate organization permits concentration and coordination of research activities, with efficient provision of direction and various aids to research, under supervision by a group of faculty members and administrators selected for their interest in the particular field or fields represented by the agency. The over-all supervision by university officials ensures responsibility in financial matters and in broad policies. The agencies are thus independent of other parts of the institution except for this quite general supervision, usually exercised by the chief governing official.

Most of the larger southern universities have one or more special agencies devoted entirely to research. The more than 100 which have been identified in colleges and universities in the 13 southern states are listed in Table 2. These agencies are too varied to fit accurately under a few headings, but some kind of classification is needed to give the list usefulness. The one used should be regarded as approximate and tentative. Some of the research agencies might reasonably be placed in more than one of the categories, and some do not fit into any of them. Obviously the agencies listed under one heading are not identical in interests or in scope of activity. In individual cases the decision had to be more or less arbitrary. For example, the Agricultural Research and Experiment Station at Tuskegee Institute does not fit precisely into

the pattern of the state agricultural experiment stations, but was grouped with them rather than elsewhere. Agencies like the Tobacco Research Laboratory at Duke University may center their work around an agricultural product but be so closely allied with a science department that they seem to belong with the natural science agencies. Some inconsistencies seem inevitable. For instance, North Carolina State College of the University of North Carolina lists its School of Textiles as a formally organized research agency, while Clemson Agricultural College has "formal experimental work in Arts and Sciences, Textiles, and Chemistry Schools." That one School of Textiles has been included and one excluded from the list of agencies undoubtedly gives too much emphasis to a distinction which is mostly if not entirely verbal. Furthermore, if this were a list of effective research units rather than organized research agencies, some of those listed would be omitted and a number of schools of medicine, textiles, and forestry would be included, along with special schools and departments which conduct extensive research programs without separate organizational machinery. The relative absence of agencies in the field of the humanities indicates that research in these subjects tends to lack formal organization. The Middle American Institute at Tulane University is an example of a type of agency which includes humanities subjects in a broad research program designed to study all aspects of a geographical and cultural area.

The University of Texas has a larger number of organized research units listed than any other institution. This may be partly a matter of terminology and administrative procedure, but it also reflects a more extensive research program than is found in most southern schools. The Universities of Alabama, Florida, Kentucky, Louisiana, North Carolina, and Oklahoma have five or more agencies. Alabama Polytechnic Institute, Tuskegee Institute, Mississippi State College, North Carolina State College, Oklahoma Agricultural and Mechanical College, Vanderbilt University, the Agricultural and Mechanical College of Texas, the College of William and Mary, the Medical College of Virginia, Virginia Polytechnic Institute, and the Universities of Arkansas, Mississippi, Tennessee, and Virginia have three or four each.

TABLE 2. SEPARATE RESEARCH AGENCIES IN SOUTHERN COLLEGES AND UNIVERSITIES, 1948

Colleges and Universities	RESEARCH AGENCIES								
	Agriculture	Engineering	Industrial Research	Natural Science	Coordinated Social Science	Government and Public Administration	Economics and Business	Education	Unclassified
Alabama Polytechnic Institute	Agricultural Experiment Station	Engineering Experiment Station		Cooperative Wildlife Research Unit (inactive)					
Tuskegee Institute	Agricultural Research and Experiment Station			The George Washington Carver Foundation	Department of Records and Research				
University of Alabama		Engineering Experiment Station		Research Laboratory in Human Nutrition		Bureau of Public Administration	Bureau of Business Research	Bureau of Educational Research	Bureau of Legal Research
		State Mine Experiment Station							
University of Arkansas	Agricultural Experiment Station	Engineering Experiment Station							Bureau of Research
									Ozark Project
University of Florida	Agricultural Experiment Station	Engineering and Industrial Experiment Station		Naval Stores Research Laboratory			Bureau of Economic and Business Research	Bureau of Educational Research	
								Bureau of Vocational Guidance	
								Curriculum Laboratory	
Georgia School of Technology		State Engineering Experiment Station	Georgia Tech Research Institute						
University of Georgia							Bureau of Business Research		
University System of Georgia	Agricultural Experiment Station								
University of Kentucky	Agricultural Experiment Station	Engineering Experiment Station				Bureau of Government Research	Bureau of Business Research	Bureau of School Service	
								Bureau of Source Materials in Higher Education	
University of Louisville			Institute of Industrial Research						
Louisiana State University	Agricultural Experiment Station	Engineering Experiment Station		Marine Laboratory		Bureau of Government Research	Bureau of Business Research	Bureau of Educational Research	
The Tulane University									Middle American Research Institute

Colleges and Universities	RESEARCH AGENCIES								
	Agriculture	Engineering	Industrial Research	Natural Science	Coordinated Social Science	Government and Public Administration	Economics and Business	Education	Unclassified
Mississippi State College	Agricultural Experiment Station	Engineering and Industrial Research Station					Business Research Station		
University of Mississippi		Engineering Experiment Station				Bureau of Public Administration	Bureau of Business Research	Bureau of Educational Research	
Duke University				Marine Laboratory					
				Tobacco Research Laboratory					
North Carolina State College	Agricultural Experiment Station	Engineering Experiment Station	School of Textiles						Institute of Statistics
University of North Carolina			Institute of Industrial Relations	Institute for Marine Fisheries	Institute for Research in Social Science	Institute of Government	Bureau of Business Services and Research	Bureau of Educational Research	Institute of Statistics
Oklahoma Agricultural and Mechanical College	Agricultural Experiment Station	Engineering Experiment Station			Social Science Research Council				
University of Oklahoma			University of Oklahoma Research Institute			Bureau of Government Research	Bureau of Business Research		Bureau of Research in Social Welfare
						Bureau of Municipal Research			
Clemson Agricultural College	Agricultural Experiment Station	Engineering Experiment Station							
University of South Carolina						Bureau of Public Administration			
George Peabody College for Teachers								Division of Surveys and Field Services	
University of Chattanooga			Industrial Research Institute						
University of Tennessee	Agricultural Experiment Station	Engineering Experiment Station				Bureau of Public Administration	Bureau of Business Research		
Vanderbilt University				Natural Science Research Committee	Institute of Research and Training in the Social Sciences				Institute for Brazilian Studies
									Humanities Research Committee
Agricultural and Mechanical College of Texas	Agricultural Experiment Station	Engineering Experiment Station		Cooperative Wildlife Research Unit					
Texas Christian University				Bureau of Research in the Natural Sciences	Bureau of Research in the Social Sciences				

Colleges and Universities	RESEARCH AGENCIES								
	Agriculture	Engineering	Industrial Research	Natural Science	Coordinated Social Science	Government and Public Administration	Economics and Business	Education Unclassified	
University of Texas		Bureau of Engineering Research	Bureau of Industrial Chemistry Research in Ceramics	Astronomical Observatory Bureau of Economic Geology Herbarium Research in Genetics Research in Zoology Biochemical Institute Brucellosis Research Institute of Marine Science Plant Research Institute		Bureau of Municipal Research	Bureau of Business Research	Bureau of Research in Education by Radio	Research in Anthropology Research in Texas History Texas Memorial Museum Institute of Latin American Studies
College of William and Mary				Virginia Fisheries Laboratory	Institute of Early American History and Culture Hampton Roads Peninsula War Studies Committee				
Medical College of Virginia				Baruch Center of Physical Medicine Institute for Clinical Research				Bureau of Educational Research and Service	
Virginia Polytechnic Institute	Agricultural Experiment Station	Engineering Experiment Station		Cooperative Wildlife Research Unit					
University of Virginia				Blandy Experimental Farm	Institute for Research in the Social Sciences	Bureau of Public Administration	Bureau of Population and Economic Research		

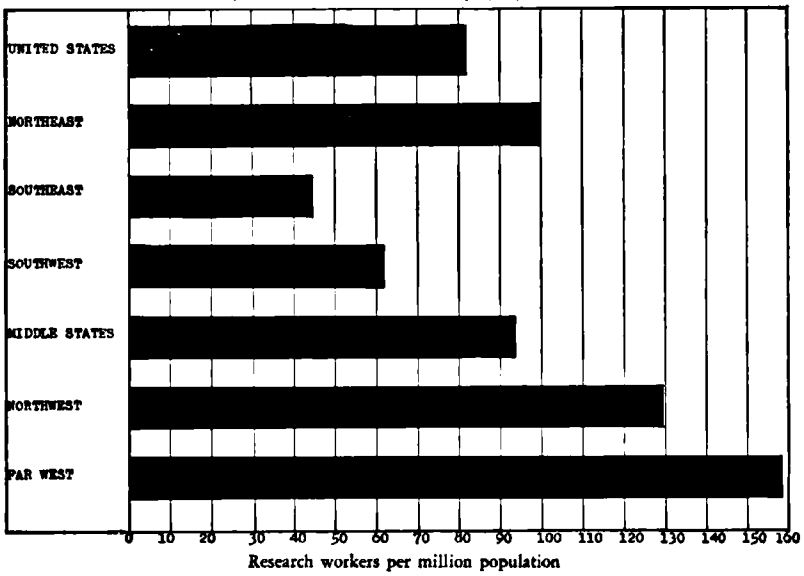
As important as the actual projects undertaken by these agencies is the indication they give of interest in the further development of research. While some of the agencies function chiefly as bookkeeping organizations with no control over the research except the original approval of a project as worthy of support, others have made full use of the procedures made possible by administrative centralization: the coordination of individual projects into a meaningful program, improved machinery for securing and managing finances, stable arrangements for sufficient time for research, more economical use of personnel and equipment aids, coordination of field research. One important gain is the specific recognition of research as an essential function of a university, for which adequate provision should be made.

Agricultural Experiment Stations. Agricultural experiment stations are associated with each of the land-grant colleges. These are the most adequately financed research agencies connected with southern colleges, receiving regular and direct federal and state appropriations. These grants are for research only, but the station programs are closely integrated with the instructional activities of the colleges where they are located in ways similar to those characteristic of other bureaus and institutes. Staff members are shared and the research problems of graduate students are frequently carried out in the experiment station under the direction of a member of the station staff. Most of the stations have branch stations and research units in the principal farming areas of their states. The main stations are organized into departments or divisions for administrative purposes, but research projects may, and often do, involve cooperation of different departments.

Because of basic similarities in the state agricultural experiment stations and because they make annual reports to the national Office of Experiment Stations, it is possible to secure exact data on their research activities and to make regional and state comparisons. In 1942-1943 there were 4,680 research workers (full- and part-time) in agricultural experiment stations in the 48 states. The 11 southeastern states had 18 percent of these, the 4 southwestern states 7.5 percent. In 1940 the Southeast had 33.5 percent of the total rural population, the Southwest almost 10 percent. In 1945-1946 the total number of research workers was smaller by

some 400; the percentage in the Southeast had increased slightly to 19.6, and that in the Southwest decreased slightly to 7.0.

Figure 27. Research Workers in Agricultural Experiment Stations, 1942-1943, per 1,000,000 Rural Population, 1940, by Regions



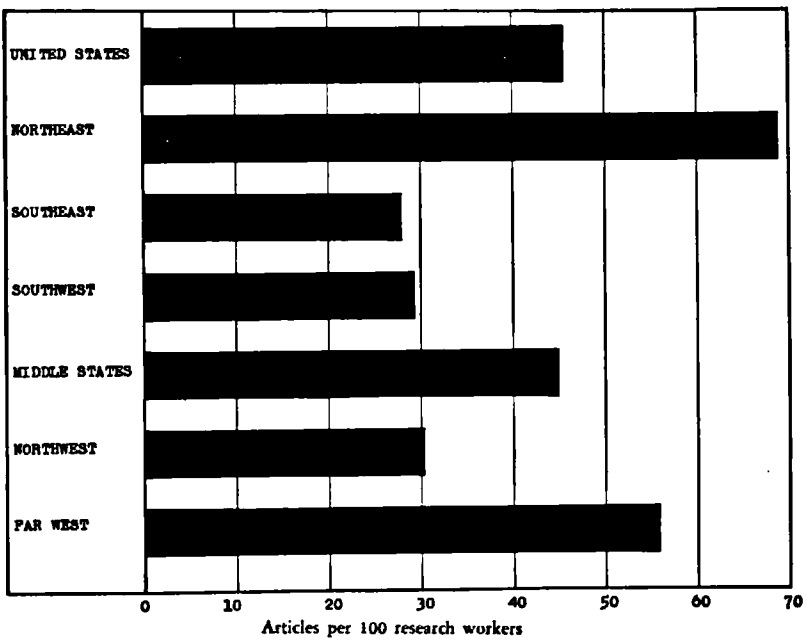
Source: Research workers from Office of Experiment Stations, United States Department of Agriculture, *Report on the Agricultural Experiment Stations, 1943,* Table I, p. 98. Population from *Sixteenth Census of the United States, 1940,* I, Table 7, p. 19.

In 1942-1943 the Southeast had 44 research workers in agricultural experiment stations per million rural population, less than any other region; the Southwest had the next smallest number, 62; while the country as a whole had approximately 82, the industrial Northeast 100, the Middle States 93, the Far West 159 (Figure 27). These regional variations are partly explained by the fact that some of the federal grants are made in equal amounts to all the states, although the more recent ones are allotted on the basis of rural population. In total federal grants, therefore, the southern states, with their large rural populations do not fare as well as other parts of the country in the assistance received for these agricultural research agencies. Nor do state appropriations to the stations make up the difference. Southern states, as a whole, make smaller appropriations for agricultural experiment stations in

proportion to their rural populations than do states of other regions.

The number of articles published in scientific journals during the year by staff members is another item reported by the stations to the national Office of Experiment Stations. When related to the number of research workers, this may be used as an index of the quality of the personnel and the research accomplished, although it is of course only a partial one. In all stations there were 45 articles per 100 research workers in 1942-1943. In the Southeast there were approximately 28, the lowest figure for any region, although the ratio was only slightly higher in the Southwest and the Northwest. The industrial Northeast led all regions with around 69 articles per 100 research workers (Figure 28). All stations did not report these data in 1945-1946, and regional figures are not strictly comparable. Using only states with complete data, the Northeast again led with 69 articles per 100 workers. It was

Figure 28. Scientific Journal Articles per 100 Research Workers in Agricultural Experiment Stations, 1942-1943, by Regions



Source: Office of Experiment Stations, United States Department of Agriculture, *Report on the Agricultural Experiment Stations, 1943*, Table I, p. 98.

followed by the Far West with 68, the Middle States with 54.5, the Southwest with 53, the Southeast with 32, and the Northwest with 29. Louisiana, North Carolina, South Carolina, and Texas were among the eight states not reporting the number of articles published.

Even considering the many factors that may affect publication, the regional differences are worth noting, since publication is an indirect indication not only of the merits of research but also of interest and participation in the broad national aspects of research activities. In a tabulation of the number of manuscripts received by the *Journal of Agricultural Research*, a publication of the United States Department of Agriculture and the experiment stations, over a period of nine years, November 1, 1929-October 1, 1938, 13.5 percent came from southeastern stations, 7.8 percent from southwestern ones. The largest regional percentage, 28.2, came from the Middle States.

Within the South, there is marked variation among the different stations. In both 1942-1943 and 1945-1946 North Carolina reported the largest actual number of research workers in the Southeast; Texas, the largest number in the Southwest; but the 1942-1943 data show Florida and Arizona far ahead of other states in the two regions in the number of research workers in relation to size of rural population. This is not entirely a matter of the equal federal grants, because Florida made the largest state appropriation given to a station in either region in both 1942-1943 and 1945-1946. In both years the Florida state appropriation was more than twice as large as the one next in size in the Southeast. In 1942-1943, the Kentucky Station led the Southeast in the number of published articles per 100 research workers, with Virginia and Florida next in order. The same stations headed the list in 1945-1946, but Florida had moved to first place. The Oklahoma Station led the Southwest in both years. The Arkansas, Florida, and Texas Stations submitted the largest numbers of manuscripts to the *Journal of Agricultural Research* in the nine-year period cited. In terms of absolute size of plant, operations, and expenditures, the Texas Station is far ahead of any other in the South.

An idea of the range of the research programs of the agricultural experiment stations may be secured from the departmental organizations. One has divisions of administration, agricultural

engineering, agronomy, chemistry, dairy husbandry, entomology, farm and ranch economics, feed control service, horticulture, plant pathology and physiology, poultry husbandry, publications, range animal husbandry, rural home research, soil survey, swine husbandry, veterinary science, wildlife research, in addition to a main station farm, substations, and field laboratories. Another has divisions of agricultural engineering, field crops, horticultural crops, livestock and poultry, soils and fertilizers, economic and social problems, and publications, and a number of branch stations. Another is divided into departments of agricultural engineering, animal industry, crops and soils, dairy research, entomology, fertilizer and feed stuffs laboratory, forestry, horticulture, nutritional research, plant pathology, poultry research, rural sociology, sugar station, veterinary science, and substations. In addition to independent station research, many projects are operated cooperatively with the United States Department of Agriculture; others with industries and state government agencies. The experiment stations maintain close relations with the agricultural extension services in their states, to which they provide data and from which they learn of special problems calling for investigation.

Engineering Experiment Stations. At least seventeen agencies in southern colleges and universities conduct engineering research. All the land-grant colleges and the Universities of Alabama and Mississippi have engineering experiment stations. In addition, the University of Texas has a Bureau of Engineering Research. The State Mine Experiment Station at the University of Alabama also seems to belong with the engineering research agencies. For the most part these agencies have had little money with which to finance research programs and their activities have been limited. There have been unsuccessful efforts, especially in recent years by the Engineering College Research Association, to secure federal support for research in the engineering experiment stations like that provided for agricultural experiment station research.

A report to the Association of Land-Grant Colleges and Universities on enginering research at member institutions in 1939-1940 shows the greatest concentration in the Middle States region. Almost half of the total funds available for engineering research and more than half of the paid research workers, publications, and current research projects were in nine institutions in eight states

in this region. The University of Illinois alone had more than three times as much money for engineering research as all the eight reporting institutions in the Southeast. The southeastern institutions reported only 4 full-time and 41 part-time paid research workers and 46 active research projects, but these figures did not include data from the Georgia School of Technology. The four southwestern institutions reported 12 full-time and 11 part-time workers and 19 active projects. The experiment stations at Virginia Polytechnic Institute, the University of Tennessee, and the University of Texas were the most active in the South, with no information for the Georgia School of Technology.

There are many indications that recent years have brought increased interest in engineering research in the southern states. A number of the agencies listed are relatively new and others are being planned. Local foundations are operating in some cases to build up funds to increase facilities and improve personnel. Relationships with industry have been improved and specific arrangements are under way to increase cooperative research. Some of the experiment stations conducted research for government agencies during the war, and there has been cooperative work with the Tennessee Valley Authority for a number of years. In 1944, the Engineering College Research Association Council published a *Directory of Member Institutions and their Principal Fields of Research*, listing the fields in which each institution is particularly well equipped and any special facilities and equipment. This type of information should be of great use to industrial groups.

Industrial Research Institutes. An even newer type of agency in southern colleges and universities is the industrial research bureau or institute, which is organized for applied and fundamental research on a commercial basis for industrial concerns, and independent research of industrial interest as permitted by finances. They are not greatly different from the engineering experiment stations, although they tend to be more definitely oriented to the needs of industry and less concerned with training. Some are incorporated independently of the institution in which they operate, but even in these cases there is close cooperation with other agencies and departments, and the actual investigations are usually conducted where appropriate equipment and personnel are located. The University of Oklahoma Research Institute is

classified with the industrial research agencies because it has functioned chiefly in this field, but its range of interest extends to other fields as well. It is difficult to draw a sharp line between the industrial research agencies and the research foundations existing in some institutions. The latter are not listed as research agencies because they are primarily legal and financial agents for other agencies or individuals who actually do the research. However, the distinction is far from clear in practice.

Natural Science Research Agencies. The research agencies classified together as miscellaneous natural science units make up the largest grouping, but this is partly a matter of using a broad category. Moreover, 9 of the 25 are in the University of Texas, which has its research program divided into an unusually large number of "organized research" units. This points up the difficulty of making numerical summaries based on classifications which are necessarily arbitrary. The figures do not indicate differences in the amount of research but in the formal organization of research activities, both among fields of investigation and among schools.

While there is more fundamental than applied scientific research in universities, one emphasis may shade into the other in specific investigations. When a research organization is built around a particular product, like tobacco or cotton, it usually conducts basic research in chemistry, biology, and other sciences, and applied research of use to both agriculture and industry. This type of combined research attack, unified by the material or materials of study, is found in a number of the agencies which have been classified in the natural science group, as the Virginia Fisheries Laboratory at the College of William and Mary, the Marine Laboratory and the Tobacco Research Laboratory at Duke University, and the Naval Stores Research Laboratory at the University of Florida.

Other research agencies are centered around a branch of science, as the Biochemical Institute and the Bureau of Research in Zoology at the University of Texas. More commonly this type of research seems to be carried out in the university departments without additional organizational machinery. Broad natural science research organizations, combining many different subjects of investigation and a variety of scientific disciplines have not been

common in the South, but their appearance is perhaps foreshadowed by the Bureau of Research in the Natural Sciences at Texas Christian University and the Natural Science Research Committee at Vanderbilt.

Coordinated Social Science Research Agencies. The coordinated social science agencies bring together workers in the various social sciences in joint research attacks on broad social problems. The Institute for Research in the Social Sciences at the University of Virginia, the Institute for Research in Social Science at the University of North Carolina, and the Institute of Research and Training in the Social Sciences at Vanderbilt University are examples. The agencies at the Universities of North Carolina and Virginia and the one formerly existing at the University of Texas were enabled to begin their programs with foundation grants large enough to set an inclusive pattern including a number of different social science subjects. The publication lists of the North Carolina and Virginia Institutes constitute an impressive record of important research accomplished. The North Carolina Institute has given special emphasis to cooperative research in which the work of many different specialists has been coordinated through central planning and direction. *Southern Regions of the United States* is a notable result of such research which has particular interest for the South. The Hampton Roads Peninsula War Studies Committee at the College of William and Mary illustrates a coordinated attack by social scientists on a more restricted problem. It is studying many different aspects of the impact of war conditions on a limited geographical area. At the University of Georgia, there was for some years loose coordination of research by social scientists on topics of interest to the state in the Institute for the Study of Georgia Problems. This agency is not functioning at present.

Government and Public Administration Research Agencies. There are 11 government or public administration research agencies in southern universities. Two bureaus are specifically devoted to municipal research. These agencies are all in state universities, and as a rule have combined some form of service to state and local government units with their research activities. The service may consist of studies made for the government agency or of consultation and advice. The Institute of Government at the University of North Carolina has developed an elaborate program

of in-service training of public officials through special short-term institutes and preparation of materials for local officials. The Bureau of Public Administration at the University of Alabama provided a research and advisory service for the State Legislature with such obvious benefits that the legislators have now established their own Legislative Reference Service to provide research service to a Legislative Council and to give research and bill-drafting service to individual members.

A number of the government research agencies in the Southeast have demonstrated the possibilities of combining efforts in a regional research program. Institutions in seven states are working with the Tennessee Valley Authority in a study of the public administration of natural resources. It is interesting to note that three of the participating universities established or reorganized bureaus of public administration as they undertook their parts in this project.

Bureaus of Business Research. The bureaus of business research usually operate in connection with a school of commerce, and in many cases a continuing function is the provision of information about current business conditions. Some of the bureaus publish a monthly review for this purpose. Activities also include studies of particular industries and their problems, taxation practices and their effects, resources for industry, and other factors affecting industry, trade, and commerce. The range of the studies varies from bureau to bureau, depending upon size and resources and upon the interests and abilities of the staff members. An instance of an unusually broad program is that of the Bureau of Population and Economic Research at the University of Virginia, which has undertaken to provide basic information about the state's resources, people, and government, and to relate these to past and future economic conditions, particularly to industrial development. A number of these bureaus, in addition to supplying and collecting general economic data upon request, will undertake special studies for private individuals and industrial concerns on a commercial basis. Two of the 13 southern states, Arkansas and South Carolina, have no business research agency. Many of the bureaus had their activities sharply curtailed during the war, but now they are expanding operations as rapidly as possible.

The United States Bureau of Foreign and Domestic Commerce

compiles an annual list of business research projects under way in educational or research institutions. These lists for southern colleges and universities show an increasing number of research projects on business and economic subjects, regardless of the existence of a formal research bureau. In 1940, 13 institutions in the Southeast reported 143 projects in 25 of the 28 fields used for classification. In 1941, 180 projects in 24 fields were reported by 17 institutions. In 1942, 21 institutions reported 182 projects in 30 of the 31 fields. The largest numbers of projects were reported by Duke University and the Universities of Florida, Kentucky, Louisiana, North Carolina, and Virginia, with marked increases for the University of Alabama and Mississippi State College from 1941 to 1942. The subjects most frequently investigated in the Southeast from 1940 through 1942 were economic history and geography; labor and labor organization; marketing; money, credit and banking; public finance and taxation; accounting; economic resource surveys and planning; agriculture. The greatest increase in interest over the three years was in economic resource surveys and planning, and in public finance and taxation. Relatively little interest was shown in commercial and business organizations, business management, occupational training and requirements, consumers and consumer organizations, housing and real property. The compilers of the lists note some geographical patterning of interests. More attention was devoted to broad national questions in the northern and eastern states, while state and local problems were investigated in southern and western states.

Educational Research Agencies. The agencies in the field of education demonstrate again the difficulties of classification. Some are primarily research agencies in a quite limited field, like the Bureau of Research in Education by Radio at the University of Texas, while others conduct investigations over a broad range of subjects. Some are primarily service agencies, providing assistance to state and local educational systems and conducting research only incidentally, while others emphasize research more than service activities. For instance, the University of Florida has a Bureau of Vocational Guidance and a Curriculum Laboratory in addition to a Bureau of Educational Research. Some would consider the former two research agencies, others would not. Generally the

service aspects of their programs have dominated the work of the southern educational research agencies.

Unclassified Research Agencies. Several agencies do not fit, even roughly, into the categories used for classification. The Institute of Statistics at the Raleigh and Chapel Hill branches of the University of North Carolina combines theoretical and applied statistical inquiries with service to other divisions of the University and to outside groups. The University of Arkansas Bureau of University Research crosses usual divisional lines and administers all research in the University outside the College of Agriculture and the Medical School. Thus the Engineering Experiment Station, which has been listed separately, conducts its research in connection with the Bureau, which carries on the functions of the usual industrial research institute along with its other activities. It is an agency which carries on research itself, and also coordinates the research of other groups. The Middle American Research Institute at Tulane University focusses its research program upon a geographical area, Middle America, with contributions from a great variety of fields—archeology, zoology, history, ethnology, botany, mathematics, economics, and others. Several quite specific social science research agencies like the Research in Texas History were left unclassified in order to keep the number of groups small. Special research projects like the Sloan Projects in Applied Economics at the Universities of Florida and Kentucky might be listed, but they are usually conducted by regular divisions or agencies in the Universities.

University Research Councils and Committees

Recently there has been a trend toward the establishment of centralized coordination and control of all research activities in universities. The development does not usually involve the dissolution of existing bureaus and institutes, but the central committees or councils which are established may take over some of the functions of the advisory boards of the special research agencies, some of the functions of the agency directors, and some of the functions of the financial and other administrative officials of the university as they are related to research activities. This movement reflects increasing interest in research, particularly

concern over securing and administering additional research funds. Again it seems to be felt that organization offers advantages, both in getting money and in getting effective research.

There are between 20 and 30 southern colleges and universities which have some kind of central research committee or council, but this number has little meaning because of the great variation with regard to function and authority. The details of the variations would become clear only with a case study of each institution, but a few general points emerge from available information.

Some of these research committees have indefinite and informal functions, such as the general promotion of research. In a number of the schools the central committee has as its chief or only function the administration of a special fund which can be used to subsidize research. The committee considers requests, allots the money, and in some cases receives progress reports. Such a committee does not centralize financial control or direction of all research activities. It simply distributes a fund, giving consideration to requests from all parts of the institution. This procedure usually leads to a fairly wide distribution of the funds in question, but it provides no means of ensuring results. Nevertheless, this method of handling research funds is considered highly successful in some schools and is used in both large and small institutions. It has the advantage of assuring the maximum freedom to the individual conducting the research. This type of research committee does not differ fundamentally in its operation from committees on fellowships and assistantships which most schools have had for a long time. When the research funds available for distribution are small they are sometimes handled by some other group such as the Graduate Board or Graduate Committee.

The more highly centralized research councils or committees serve as real administrative bodies, although there is no exact pattern into which any considerable number of these bodies can be fitted. Some of them control most of the money spent for research, approving projects and allotting funds to them (or recommending them to a foundation), clearing all requests to outside agencies for research funds, and making all contracts with outside agencies. They may also initiate projects, exercise supervision over all projects being financed, and award research fellowships and assistantships. Committees or councils which centralize at least

a part of the authority and control with regard to research exist at Alabama Polytechnic Institute, Emory University, Georgia School of Technology, Tulane University, North Carolina State College, Duke University, Clemson Agricultural College, George Peabody College for Teachers, Vanderbilt University, and the State Universities of Florida, Georgia, Mississippi, South Carolina, and Virginia. There are variations among these, but they can be considered together as representing the move toward centralization. It is notable that Texas, with its extensive research program, has not centralized authority to this extent. There the University Research Institute, through a Research Council, administers a fund for grants-in-aid to faculty members in the form of research leaves, assistants, equipment, and publication, but the various organized research units operate independently of it.

In 1946 The Carnegie Foundation for the Advancement of Teaching initiated a five-year experimental cooperative program of grants-in-aid for research to be undertaken by college professors in the southeastern states. Four strategically located centers, each composed of one university group and at least five neighboring undergraduate colleges, have been organized. The centers are: University of North Carolina-Duke University; Vanderbilt University-Peabody-Scarritt College; Emory University-Georgia School of Technology-University of Georgia; Tulane University. The Foundation has granted a total of $140,000 annually which is supplemented by an additional $40,000 made available annually by the institutions. Allocations to individual professors for support of their research undertakings are made by a designated local research authority in each participating institution. The program is now being extended to a number of Negro colleges and universities in the South.[14]

Research Foundations

A further development in the direction of concentrating legal and financial functions connected with university research is the establishment of research foundations as incorporated financial bodies. These foundations are more clearly separated in organization and function from university control than the special re-

[14] *The Carnegie Foundation for the Advancement of Teaching, Forty-Second Annual Report, 1946-47* (New York, 1947), pp. 23-27.

search agencies or the research councils. They often include representatives from industry and professional groups in addition to university officials. These members elect a board of directors which conducts the business of the foundation. Thus business and industrial groups are brought into a closer relationship with university research and provided with a definite way to assist and influence the program. It seems clear that the need for a research foundation would be felt more keenly in an institution which conducts research in engineering and industrial fields, where relationships with industry are important both in the support and practice of research, and where questions of patent rights may arise.

Alabama Polytechnic Institute, Tuskegee Institute, Georgia School of Technology, Oklahoma Agricultural and Mechanical College, Clemson Agricultural College, the Agricultural and Mechanical College of Texas, Vanderbilt University, Virginia Polytechnic Institute, and the Universities of Arkansas, Kentucky, Louisville, Oklahoma, and Tennessee, have research foundations serving as the legal and financial agents for research activities. Other schools are contemplating the establishment of foundations. These bodies receive research funds and allot them to projects, execute contracts with outside agencies, hold patents, and in other ways carry out the functions of a business corporation. They may operate in conjunction with a research committee which serves as a liaison between individuals and agencies conducting research and the foundation.

Foundations which limit their activities to fund raising and general promotion also exist in connection with southern colleges and universities. These may be for one school or division of a university; examples are the foundations which have been set up to provide more adequate support for research and training in textile schools. The Business Foundation of North Carolina has the broad objective of aiding and promoting all types of education, service, and research for business and industry at the Chapel Hill branch of the University of North Carolina.

A RALLYING POINT FOR COMMON ACTION

It was not necessary to make a detailed account of college and university research resources in the South to establish the fact that

the southern regions lack adequate resources in this field and, as a consequence, do not have the fundamental research on regional problems which is needed or a sufficient supply of trained research personnel for industrial, governmental, or other research activities. More than fifteen years ago Dr. Wilson Gee made this abundantly clear in his study, *Research Barriers in the South*. There have been improvements since that time, but the basic fact of inadequacy remains the same.

This analysis of the research activities and organizations of southern colleges and universities was made to provide information of use to various organizations, including the schools themselves which may concern themselves with improving conditions, removing the barriers, correcting the inadequacy. Appreciation of the need for more research facilities is not enough. There must be understanding of the variety and complexity of factors that make up the research resources of a university and awareness that all must be improved if these institutions are to play their part in building up the basic knowledge and the technological skill which the South needs so critically. The information given here, together with that from other sources indicated, can provide a basis for practical assistance to southern universities. More detailed information will be needed in special cases, studies such as the survey of work in chemistry made by Dr. J. E. Mills and his committee for the National Research Council in 1930, but such studies can go forward from the general data provided.

The time is ripe for action by all interested groups. Colleges and universities are increasingly aware of their own needs and almost all of them are working on plans to reorganize and amplify their research programs. The public knows more of the accomplishments and potentialities of research and is ready to provide more support for it. This has already been demonstrated by the action of state legislatures, notably in Alabama. The return of men from the Army and Navy has called attention to training needs, and many schools are in the process of changing and modifying their procedures for training. Industrialization, with its research demands, increases in the South, and leaders are urging more of it to improve the economic level of the people of the region.

Careful planning and coordination of effort will make the most

of the opportunity presented. There should be closer relationships between universities and private industry, with better understanding by each of the needs and functions of the other. Greater cooperation among universities themselves will avoid needless duplication of expensive facilities. A regional rather than a state view is required for consideration of the desirability and feasibility of building up a number of great research centers which can serve the whole South. Southern statesmen, farmers, and industrialists must learn to work together for concrete goals if any of them are to move rapidly toward their desires, and one place where they can cooperate without conflict is in the support of research institutions which serve them all individually and, at the same time, the general welfare. Each group may make its own particular contribution, whether in the form of industrial scholarships and grants or in the support of public appropriations, but all will benefit.

IV

GOVERNMENTAL RESEARCH

THE RANGE OF GOVERNMENTAL RESEARCH

RESEARCH is conducted by many different agencies of government, federal, state, and local, and governmental research personnel and facilities are important resources of the nation and of the various regions. With the steadily increasing range of other government activities, research in government has also grown, and the present trend is toward even more government responsibility for the conduct, encouragement, and financial support of research.

Governmental research is varied in function, type, and subject matter. Many investigations are conducted to provide information necessary for the performance of other governmental functions. This subsidiary research has necessarily grown in extent and variety as government activities have increased in amount and complexity. The results of these studies may be of use to other groups and individuals, but as a rule their usefulness is limited by the relatively narrow and specific purposes for which they are undertaken. Usually there is no effort to make the findings public, and sometimes they are considered confidential by the agency concerned. Such studies tend to be of short duration. They are closely similar to the applied research of the industrial corporation. They may be carried on in any field which bears upon the formation of policy or the execution of governmental functions. Thus, economic data are needed for the determination and execution of tax policies; continuing research on new weapons is essential if the Army and Navy are to perform the duties assigned to them; the Interstate Commerce Commission and state corporation commissions must base their regulatory activities on accurate information. In the Federal Government and in some of the state and local governments there are special divisions and bureaus of regular departments which conduct the needed studies and investigations. In other instances studies are made intermittently when needed by regular staff members or by contract with an outside research agency.

A second broad category of governmental research activity includes the collection and classification of data and the establish-

ment of standards. These activities may not be considered research in a narrow sense, but they are essential to other investigations and they require a high degree of skill if they are planned and carried out effectively. Governmental collections of data provide many of the basic research materials of the social sciences, and governmental classification and standardization activities are important to the natural sciences and to industry. These broad research-related programs can be conducted more effectively by public agencies because they require uniform procedures and complete coverage. Furthermore, they offer no financial return to the private individual or company. Only government has both facilities and obligation to provide these services, and in many cases only the national branch of government qualifies. Research of this type is neither pure nor applied, and has been appropriately called "background research" by the Committee on Science and the Public Welfare, one of the groups which assisted Dr. Vannevar Bush in preparing his report, *Science the Endless Frontier.*

> The preparation of accurate topographic and geologic maps, the collection of meteorological data, the determination of physical and chemical constants, the description of species of animals, plants, and minerals, the establishment of standards for hormones, drugs, and X-ray therapy; these and similar types of scientific work are here grouped together under the term background research. Such background knowledge provides essential data for advances in both pure and applied science. It is also widely used by the engineer, the physician and the public at large. In contrast to pure science, the objectives of this type of research and the methods to be used are reasonably clear before an investigation is undertaken. Thus, comprehensive programs may be mapped out and the work carried on by relatively large numbers of trained personnel as a coordinated effort.[1]

Although background research may involve reporting or collection systems which cover the entire country, the results are usually collated and made available from a central office. Agencies like the Bureau of the Census and the Bureau of Standards in the Federal Government are devoted to background research. Other governmental agencies perform this type of research in connection with other duties. State and local governments compile data for

[1] Vannevar Bush, *Science the Endless Frontier* (Washington: Government Printing Office, 1945), p. 76.

the areas they cover, frequently in collaboration with a federal bureau which provides national summaries.

In still other instances government agencies conduct specific research projects, not for their own use, but for use by other government agencies, by outside groups, and by the public at large. These governmental research programs have been established to supply needs which were not being met by private organizations or individuals. Most of the investigations constitute applied rather than basic research. In *Science the Endless Frontier* it is estimated that 15 percent of governmental research was "pure research" before the war; *Science and Public Policy* gives 9 percent as the postwar figure. The subject matter of these investigations varies widely, with the need for governmental research more pressing in new fields. Thus emphasis may shift, with private research agencies taking over a field in which public ones have pioneered, leaving government to go forward in another direction. Special agencies may be set up for the conduct of this kind of research, such as the National Advisory Committee for Aeronautics, or it may be conducted in a previously existing bureau or division. Projects may also be commissioned from non-governmental agencies, or personnel and equipment may be shared through cooperative arrangements.

State and local governments have not had resources or demands for scientific investigations comparable to those which have led to the growth of research agencies in the Federal Government. Their direct use of research is more closely limited to studies needed for the operation of departments and to the collection of statistical data. Evidence of increasing use of research by departments of state governments can be found in the growing number of permanent bureaus or divisions of research and statistics. Special studies may also be made by regular personnel or by contract with other agencies. The state geological surveys and, in recent years, state planning boards are examples of agencies which have made investigations of more general scientific interest. In some of the states elaborate research programs, pure and applied, are promoted through the support given state universities and agricultural experiment stations; in others the support given to research of any kind is still at a minimum.

Both the Federal Congress and the state legislatures conduct

investigations in connection with pending bills. These may be made by standing or special committees of the legislative bodies, administrative agencies may be directed to make them, or commissions may be set up and empowered to employ experts in the relevant field. Some of these investigations are perfunctory or partisan, but many have made valuable contributions to knowledge. In general, those made by state legislative committees have been less extensive and less carefully conducted than the congressional ones, and their results are less frequently made public. On the other hand, the state legislatures have made more use of special commissions with staffs of experts. Most of the states also have legislative reference services which provide needed information to lawmakers.[2]

The research activities of county and city governments have been almost entirely limited to specific problems of immediate concern to the governing unit. Permanent research agencies are not common, although some cities have research bureaus. The money spent for research usually goes for special projects, limited in aims and in duration. Organizations of public officials and leagues of municipalities perform some research functions for city and county governments, and in some cities privately supported bureaus of municipal research have given research aid to city departments.

GOVERNMENTAL RESEARCH IN THE NATION

During the war period the Federal Government dominated research activities, financing about 83 percent of all research and development work in the physical and biological sciences during the years 1941-1945, according to *Science and Public Policy* estimates. The 1947 estimates give 54 percent as the share of the Federal Government. These estimates exclude expenditures on atomic energy research. In his report for the prewar period, Dr. Vannevar Bush estimated all government research to be much less than industrial research but more than college and university research.

[2] For an extended account of legislative research see Section 5 of National Resources Committee, *Research—A National Resource. I. Relation of the Federal Government to Research* (Washington: Government Printing Office, 1938), pp. 115-164.

FEDERAL RESEARCH

In a study made by the National Resources Committee in 1938, 133 bureaus, major offices, and independent establishments in the Federal Government were found reporting expenditures for research in one or both of the fiscal years 1937 and 1938. The departments with the largest numbers of agencies reporting research were Agriculture, State, Interior, and Treasury, but the independent agencies had more units engaged in research than any one of these. Five departments, the four mentioned and the War Department, spent approximately three-fourths of the regular funds allotted to research in the Federal Government, agricultural research accounting for 37 percent of all regular research expenditures. In 1938, 31 agencies reported that at least half of their expenditures were for research, and 16 reported more than 99 percent. The *Science and Public Policy* figures for 1947 show the War and Navy Departments accounting for 80 percent of federal research expenditures. The Department of Agriculture came next with 5 percent. Only four other agencies spent as much as 1 percent, Department of the Interior, the National Advisory Committee for Aeronautics, the Federal Security Agency, and the Department of Commerce. The Atomic Energy Commission is excluded.

The total expenditures by the Federal Government for research purposes were around 125 million dollars in 1937, 100 million dollars in 1938; from regular funds the research expenditures were 70 million dollars in 1937, 78 million dollars in 1938. The largest proportion of this money went for research in the natural sciences, 48 percent of the total and 60 percent of the regular research funds in 1938. Social science research received more support from emergency funds. Federal expenditures for research were increasing even before the war influence was felt. Data for the Department of Agriculture and 13 other agencies show an increase of more than 120 percent between 1923 and 1938. *Science the Endless Frontier* estimates that governmental research, including states and localities, in the natural sciences and medicine increased 200 percent from 1930 to 1940. *Science and Public Policy* shows Federal Government expenditures for research and development in the physical and biological sciences (excluding atomic research) growing from 23 million dollars in 1930, to 67 million dollars in 1940, and to 625 million dollars in 1947.

STATE AND MUNICIPAL RESEARCH

Although a complete account is not possible, there are indicators which can be used to show what the state governments are doing in research. Only 3 states had no legislative reference service listed with the Council of State Governments in 1946, although 16 additional ones had no division or department devoted exclusively to this service. Thirty-three states listed research as one of the functions of their legislative reference service agencies. A tabulation by the National Resources Committee of reports from commissions established by state legislatures to make investigations of a general character lists 134 studies between 1877 and 1937 dealing with the electoral, legislative, judicial, and administrative branches of government. In 1915, when the Bureau of the Census first started publishing figures on state expenditures, 17 states spent $200,000 for special investigations by state legislatures; in 1938, 27 states spent more than $1,000,000. State grants to agricultural experiment stations totaled $19,000,000 in 1944, state appropriations to geological surveys $1,750,000. These two agencies account for a large proportion of the money which states appropriate directly for research.

There has been relatively little formal research conducted by governing units below the state level, with the exception of some of the larger cities. Here the city manager movement and the general trend toward improvement of city government has led to increasing awareness of the need for accurate information as a basis for general city planning and for the functioning of various departments. Data are needed for activities as varied as framing a sanitation ordinance, making up a budget, and drawing up zoning plans. The methods range from informal inquiry and limited consultation of references to elaborate surveys, field trips to other cities, and consultation with experts. These inquiries may be conducted by administrative staff members, by regular department staffs, or by a special research agency. In other cases outside agencies are used for special studies. Municipal reference libraries have been established in some cities to facilitate investigations.

When there is a special research bureau in the city administration, its activities may include regular compilation of records and statistics in addition to special investigations as they are needed. An important function of some bureaus is the preparation of

technical material for hearings in which the city has an interest, such as air route hearings, and for loan and grant applications, such as those made to the Federal Works Agency. Wherever a liaison unit is needed in relations with other government agencies or private organizations, the municipal research bureau may serve. It may also be responsible for budget preparation, which necessarily involves study related to all departmental functioning.

Out of 94 cities with populations of 100,000 or more in 1937, 34 reported to the Bureau of the Census expenditures for research bureaus or special research projects. The number was 35 out of 94 cities in 1939, and 49 out of 92 cities in 1942, indicating more widespread use of research although the total amount expended had decreased from $926,000 in 1939 to $676,000 in 1942. New York City spent almost half of the total in 1939 and more than half in 1942. Less than a third of the cities reporting expenditures for research in 1937 and 1939 had regular research bureaus; the greater number made their expenditures for special projects. In the 1942 reports only the total amount was given.

These figures indicate that the research activities of state and local governmental units have not bulked large. This may be explained partly by the special fitness and greater financial ability of the Federal Government to perform many of the clearly recognized governmental research functions, but it is also due to a slower appreciation by states and cities of the need for research in connection with their activities and the responsibility to provide research when it is urgently needed and is not being provided by private organizations. This latter responsibility has been partially discharged by state grants to agricultural experiment stations and geological surveys and research grants to colleges and universities.

Recognition of the need and responsibility have been growing, and non-federal governmental research seems likely to increase as trained personnel becomes more widely available. Many state governmental agencies had their staffs curtailed during the war, but they are ready to renew their research programs as legislative support is given. Antagonism toward governmental planning has resulted in the abolition or emasculation of some state planning boards, agencies which have usually been active in conducting and coordinating state research. At the same time the activities of planning boards have resulted in increased use of research by other

state bureaus and departments. Federal assistance for state conducted research may also lead to an increased interest on the part of state governments.

GOVERNMENTAL RESEARCH IN THE SOUTH

FEDERAL GOVERNMENT RESEARCH IN THE SOUTH

In one sense all the research resources of the Federal Government are resources for the South, as they are for the entire country. They should become better known to southerners in order that the fullest possible use can be made of them. The first volume of the *Research—A National Resource* series of studies, *Science the Endless Frontier,* and the second volume of *Science and Public Policy* all provide information about research in the Federal Government. Some of the agencies carry on all their work in central Washington offices, while others, like the research bureaus of the Department of Agriculture and the Fish and Wildlife Service of the Department of the Interior, operate branch research units throughout the country. It is these branches which properly belong in a listing of regional research resources.

Federal agencies also contribute directly to state research programs by supplying personnel and expenses for cooperative projects and by grants-in-aid for general research purposes. Another contribution of great importance to the region is the coordination accomplished through regional laboratories and offices and through the promotion of nation-wide and region-wide research programs in which state and local research units participate, either through voluntary agreements or through the conduct of similar projects partly financed by a federal agency.

The Department of Agriculture

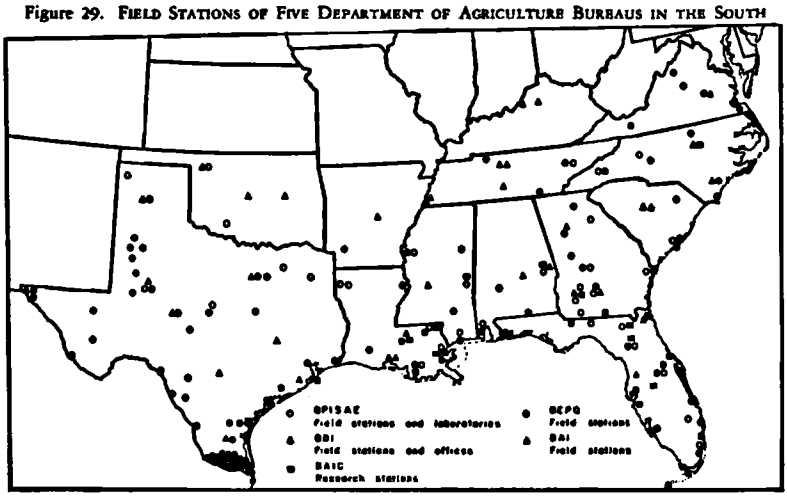
The Department of Agriculture, through its research divisions, brings science to the aid of agriculture as private industrial research provides scientific knowledge for industry. Within the Department the research agencies and bureaus are grouped together under the Agricultural Research Administration. These bureaus conduct investigations in headquarters laboratories in Washington and the Beltsville, Maryland, Research Center and in numerous research units scattered through the states. In addition,

projects are conducted in cooperation with other research agencies. A further research function is carried out by the Office of Experiment Stations which administers federal grants to the agricultural experiment stations and helps to coordinate the state programs.

There are varying arrangements in the bureaus for conducting research. Some do most of their work in central laboratories, while others have numerous field research stations. In September, 1944, the Agricultural Research Administration was administering directly approximately 135 field stations and laboratories in 105 locations in the 13 southern states. In addition, the Forest Service was operating regional experiment stations at Asheville and New Orleans, and the Soil Conservation Service was conducting (in March, 1943) 90 research projects in 11 of the 13 states. The Bureau of Agricultural Economics had regional offices in Atlanta, Georgia, and Little Rock, Arkansas, where its research activities in the region were centered, and its Division of State and Local Planning had a representative in each state. There were also agricultural statistics field headquarters in each state. These research units vary in size; among the larger ones are the Southern Regional Research Laboratory at New Orleans, the regional Vegetable Breeding Laboratory at Charleston, South Carolina, and the regional Animal Disease Research Laboratory at Auburn, Alabama. In the regional offices of the Bureau of Agricultural Economics three divisions—Farm Population and Rural Welfare, Farm Management and Costs, and Land Economics—conduct research, and the Regional Analyst's office coordinates the work of the divisions and promotes cooperative relations with the states. The Bureau of Plant Industry, Soils, and Agricultural Engineering and the Bureau of Entomology and Plant Quarantine accounted for more than 80 percent of the federal units in the Southeast at the date of this count, but many of their units are small. The Southern Regional Research Laboratory at New Orleans and the other regional laboratories come under the Bureau of Agricultural and Industrial Chemistry. Florida and Louisiana had the largest numbers of federal units, while Kentucky had the smallest number. An indication of the extent of federal agricultural research in the region is given in Figure 29, which consolidates the maps of five bureaus showing the approximate location of their field stations in the South. Where cooperative projects and offices were dis-

tinguished on the original maps from laboratories and research units, only the latter were included.

Figure 29. Field Stations of Five Department of Agriculture Bureaus in the South



Note: The abbreviations stand for the Bureau of Plant Industry, Soils, and Agricultural Engineering, the Bureau of Dairy Industry, the Bureau of Agricultural and Industrial Chemistry, the Bureau of Entomology and Plant Quarantine, and the Bureau of Animal Industry.
Source: United States Department of Agriculture maps.

Both the directly controlled federal research programs and the cooperative projects with agricultural experiment stations vary in extent from time to time, depending upon the urgency of particular problems in different parts of the country, upon the broad research programs of the federal bureaus, and upon the size of congressional appropriations for agricultural research. It is therefore not possible to show differences in the amount of agricultural research conducted by the national government in various parts of the country without distorting the essential fact of its national character. It is, nevertheless, of interest to a region otherwise backward in research development to discover the extent to which federal government activities help to improve its relative standing in research.

There is a tendency to spread the larger federal research stations somewhat evenly through the country, and this puts the South at least on a level with other regions. On the other hand, there is, at any given time, variation in the total amount of federally conducted agricultural research in the different states.

In 1941, for example, six of the principal research bureaus in the Department of Agriculture had a research staff of between 1,600 and 1,700 in field stations in the 48 states. The largest numbers were concentrated in the states where the four regional laboratories of the Bureau of Agricultural Chemistry and Engineering[3] were located, but there are regional differences not accounted for by these laboratories. For the country as a whole there were approximately 30 of the research workers per million rural population. Three regions, the Northeast, the Southeast, and the Middle States had less than the national figure, while the Southwest, the Northwest, and the Far West had more, particularly the Far West, with nearly three times as many of the federal research workers per million rural population as the nation at large.[4]

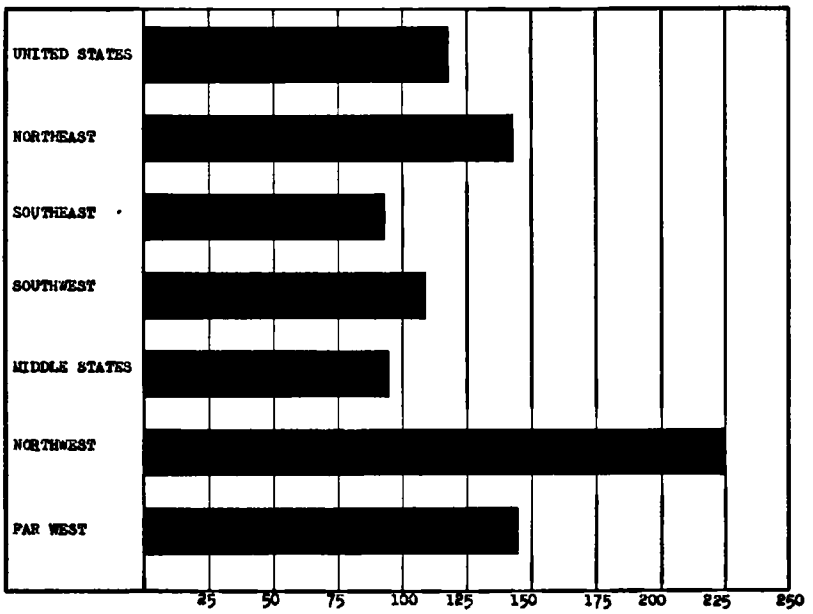
Since factors other than need, including political considerations, may enter into the distribution of federal research facilities, it should not be surprising that federal agricultural research workers are not located according to the size of rural populations and that some less rural regions therefore have a certain relative advantage over others with larger rural populations, in the sense that their need for agricultural research is proportionately less and their assistance from the Federal Government is in some cases greater than that given more rural regions. For instance, California had in 1940 a rural population slightly smaller than that of Georgia or Illinois and slightly larger than that of Kentucky or Alabama. But, omitting the personnel of the regional laboratories in California and Illinois, California had in 1941 more than three times as many field research workers from the six agricultural bureaus as either Georgia or Illinois, more than six times as many as Alabama, and an even greater over-representation by comparison with Kentucky. This difference is not pointed out to suggest that federal research programs should be determined by any one factor. Since, however, there is benefit from having research

[3] In a later reorganization this Bureau was renamed the Bureau of Agricultural and Industrial Chemistry.

[4] The tabulation of research personnel was made from the *Directory of Organization and Field Activities of the Department of Agriculture: 1941*, Miscellaneous Publication No. 431. The list of workers is not complete in all fields but is intended to be so for research. (See Introduction, p. 1.) In the tabulation only research divisions of the six bureaus (Bureau of Agricultural Chemistry and Engineering, Bureau of Animal Industry, Bureau of Dairy Industry, Bureau of Entomology and Plant Quarantine, Bureau of Plant Industry, Soil Conservation Service) were included. Since the list was not intended as a statistically accurate count, and since it was difficult to be sure that all cooperating or collaborating personnel were excluded in the tabulation, exact figures are not given here.

done in a region, the point of importance for the southern regions is that federal agricultural research does not compensate for their deficiencies. The South cannot depend entirely upon the Federal Government to bring its use of science in agriculture up to a level with that of other regions.

Figure 30. Federal Grants to Agricultural Experiment Stations, 1942-1943, per 1,000,000 Rural Population, 1940, by Regions



Thousands of dollars per million rural population

Source: Federal grants from Office of Experiment Stations, United States Department of Agriculture, *Report on the Agricultural Experiment Stations, 1943*, Table 2, p. 100. Population from *Sixteenth Census of the United States, 1940*, I, Table 7, p. 19.

In addition to direct field research activities of the Department of Agriculture, federal grants for agricultural research are made to the states for their agricultural experiment stations. The older grants allow an equal amount to each state, but the later Bankhead-Jones Act makes appropriations in proportion to rural population. This provision now gives the South, with its large rural population, a more adequate proportion of the federal funds, but the earlier provision for equal grants gave a relative advantage to other regions which received more money in proportion to their need

for agricultural research. The total amounts still reflect this condition, as can be seen in Figure 30, where the Southeast, the Middle States, and the Southwest, the great agricultural regions, are shown to suffer a relative disadvantage in comparison with the Northeast, the Northwest, and the Far West.

It is important to stress the fact that the benefits to the South from the research program of the Department of Agriculture are not limited to the work actually conducted within its borders. The advice of experts in the federal bureaus is available to southern research workers, and the reports of research published in the *Experiment Station Record* and in the *Journal of Agricultural Research* are of great assistance. Department aid also facilitates cooperative programs among the state agricultural experiment stations.

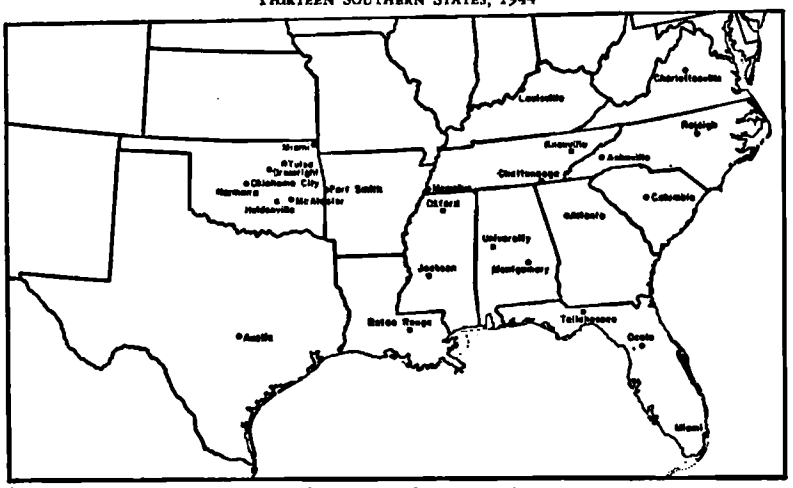
The Department of the Interior

Several bureaus and divisions of the Department of the Interior conduct research through field stations. The United States Geological Survey had field offices in 84 different locations in 44 states in September, 1944. All the field offices of the Conservation Branch were in the Southwest, the Northwest, and the Far West. The Geologic and the Topographic Branches together had seven regional field offices, of which one, a Topographic Branch Office in Chattanooga, Tennessee, was in the South. The Water Resources Branch had 18 field offices in the Southeast, 15 in the Southwest, with at least one in every state. The locations of field offices in the South are indicated in Figure 31. In addition to the regular work of the field offices, the Survey sends special workers wherever they are needed to carry on its investigations and to cooperate with other agencies, private and public, in needed studies of mineral and water resources. Close relationships are usually maintained between its workers and those of the state geological surveys.

The research work of the Bureau of Mines is carried on chiefly in experiment stations and other branch units in the principal mining districts of the country. The units in the 13 southern states are: the Southern Experiment Station at Tuscaloosa, Alabama; the Electrotechnical Laboratory at Norris, Tennessee; the Petroleum and Natural Gas Experiment Station at Bartlesville, Oklahoma; the

Bauxite Pilot Plant at Bauxite, Arkansas; the Ferroalloy Pilot Plant at Raleigh and the Sponge Iron Pilot Plant at Salisbury, North Carolina; the Helium Production Plant at Amarillo, Texas; and the Mount Weather Testing Adit at Bluemont, Virginia.

Figure 31. Locations of Field Offices of the United States Geological Survey in Thirteen Southern States, 1944



Source: Mimeographed list provided by the United States Geological Survey, September 1, 1944.

The Fish and Wildlife Service operates fishery laboratories at Beaufort, North Carolina and Pensacola and Welaka, Florida, fishery stations at Pisgah Forest, North Carolina and Fort Worth, Texas, a field station at New Orleans, Louisiana, and a wildlife refuge at McClellanville, South Carolina. The regional headquarters for investigation in middle and south Atlantic fisheries are at the University of Maryland. The research program on fisheries consists mostly of long-time, fundamental investigations, but specific local problems are studied when they have national or regional significance. These problems are frequently brought to the Service by state fish and game agencies. Most of the wildlife research of the Service is in other parts of the country, but three of the ten cooperative wildlife research units are located at southern land-grant colleges—Virginia Polytechnic Institute, Alabama Polytechnic Institute, and the Agricultural and Mechanical College of Texas.

The Department of Commerce

Two divisions of the Department of Commerce conduct research through field studies, the Coast and Geodetic Survey and the Weather Bureau. The Weather Bureau makes regular investigations through six field stations in the South, located in Florida, Louisiana, North Carolina, Tennessee, and Virginia. In addition it has nine forecasting centers in five states—Florida, Georgia, Louisiana, North Carolina, and Texas. The investigations made by the Coast and Geodetic Survey do not, as a rule, require permanent field offices, and some of its observation posts are automatic and require only occasional attention. It has, in the years of its operation, made elaborate studies throughout the country and particularly along the coasts. The regional and district offices of the Bureau of Foreign and Domestic Commerce make reports analyzing business conditions on a regional basis, but for the most part they are centers of distribution of information, including results of the research conducted in the Washington offices.

Other Federal Departments

Scattered through the other federal departments are a few bureaus and divisions which maintain branch research units, such as the Public Health Service of the Federal Security Agency. It maintains a malaria research station in Memphis, Tennessee and a malaria laboratory in Columbia, South Carolina. Other agencies make field studies in various parts of the country intermittently, and cooperate with state and local agencies in research, examples being the Public Roads Administration of the Federal Works Agency, the Army Corps of Engineers, the Children's Bureau and the Bureau of Labor Statistics of the Department of Labor, and the Office of Education in the Federal Security Agency.

At any given time special federal agencies may also be conducting research in different parts of the country. During the thirties emergency programs made some studies and financed others. Short-lived agencies like the National Resources Planning Board have made studies of great importance for the South. During the war special research programs were conducted by the War Production Board, the War Food Administration, and especially the Office of Scientific Research and Development. The Cotton and

Fiber Branch of the War Food Administration operated three laboratories in the South, but for the most part war-related research was concentrated in the parts of the country with better research facilities. In 1947 the Federal Power Commission completed a power-market survey which covered Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, and eastern Mississippi.

The Tennessee Valley Authority

The Tennessee Valley Authority is a federal agency located in the South and working in a number of ways for the development of a southern area. Its operating responsibilities are principally confined to construction of dams, operation of a power system, production of fertilizers for experimental purposes, and construction of a navigable river channel, but it is also authorized to conduct research related to the development of the natural resources of the Tennessee River drainage basin for the general purpose of fostering the physical, economic, and social development of the area.

Scientific research is an integral part of all the activities of the Authority. To determine what projects are needed and feasible in order to achieve river control requires engineering studies and investigations, surveys, maps, and reports involving hydraulic, geologic, topographic, soil, and cadastral data. In connection with the control of water on the land, the Authority has investigated and developed equipment and processes to facilitate this control, it has worked on new and cheaper processes for the production of more concentrated fertilizers, and it has experimented with means of demonstrating and spreading the use of the improved plant food. The broad authorization to promote the economic and social development of the Valley area calls for research, studies, experiments, and demonstrations related to the conservation, use, and development of all types of resources. Studies have included the basic natural resources, general economic and social conditions, and resource utilization. Particular attention has been given to research which will aid in the development of further processing of raw materials available in the Valley, and to investigations which will assist in the establishment of new small business units. The large-scale chemical plant at Muscle Shoals has been of great

service to private industry throughout the country through its research on the processing of fertilizer materials and munitions of war.

The Authority has demonstrated throughout its history the contribution which a wise use of science can make to the solution of a wide variety of problems. Its use of research in the program of Valley development might be taken as an object lesson in what the South needs to do in an effective program of regional development. Much of the research of the Authority is conducted in cooperation with other agencies, making use of existing facilities whenever they are available. It has worked directly with other federal agencies, as in malaria studies with the United States Public Health Service and forest products research with the Forest Service. It has worked with state agencies, as in cooperative projects with state geological surveys and with colleges and universities, particularly through agricultural experiment stations and engineering experiment stations. Many of its cooperative projects involve several different agencies, each contributing a part of the needed research. In one program, for instance, an engineering experiment station worked on decorticating and degumming flax so that it could be used on cotton-mill machinery; another engineering experiment station operated an oil seed processing pilot plant for studying by-product oil possibilities from the seed of the fiber flax; and two agricultural experiment stations worked on problems connected with growing flax for the processing operations. In another instance one engineering experiment station worked with the Authority on the development of a process for high-speed freezing preservation of locally grown products. The agricultural experiment station of the same university worked on improved varieties suitable for freezing preservation, and the State Extension Service worked on the production of the improved varieties in the field. Another agricultural experiment station in another state worked on the utilization of the frozen products produced.

In another type of cooperative program the Tennessee Valley Authority is cooperating with the North Carolina State College of Agriculture and Engineering of the University of North Carolina in equipping and operating a minerals laboratory on land deeded by the City of Asheville. The agreement provides for use of the laboratory facilities by the United States Bureau of Mines and the

North Carolina State Department of Conservation and Development in addition to the Authority and the College. A private mining engineer has contributed a minerals collection for the building.

The value of thus bringing together various interested groups and effecting coordination of research activities is tremendous, both in the results accomplished and in the example set for other agencies and organizations. This type of program strengthens existing institutions and promotes a regional approach through inter-state cooperation on common problems. The wide participation of local institutions responsive to the people who support them provides a means for ensuring research related to local needs and a channel for getting research findings to the people who can use them. In developing and demonstrating practical ways of coordinating research the Tennessee Valley Authority has made one of its greatest contributions to the whole southern region.

RESEARCH BY STATE AGENCIES IN THE SOUTH

In the South, as elsewhere, the research activities of state governments are relatively limited by comparison with the extensive program of federal research. There are few state government agencies with research as a principal function, and the range of topics investigated is much smaller.

Legislative Research

With the exception of Tennessee, all southeastern and southwestern states have some department or agency in charge of a legislative reference service to provide needed information for the state legislators. This duty is often assigned to an existing agency, such as the State Library. The 1946 *Book of the States*, published by the Council of State Governments, shows that three southeastern states, Alabama, North Carolina, and Virginia, then had specific divisions with separate personnel devoted exclusively to legislative reference service. Ten southeastern and southwestern states listed research as a function of their legislative reference services. Alabama, Kentucky, and Virginia also have Legislative Councils to assist legislators and the administrative branch of state government through advance consideration of important measures and recommendations made on the basis of careful study. These Councils

employ research staffs; in Alabama, the Legislative Reference Service is the research arm of the Legislative Council.

Between 1915 and 1939 every southeastern state reported expenditures for at least one legislative investigation. In the Southwest, Oklahoma reported no expenditures for this purpose and Texas less than $500. These investigations are by their character irregular in time and variable in cost. Consequently, direct comparisons among regions are not meaningful. Nevertheless, it is clear that legislatures in the Northeast have made the most extensive use of financed investigations, with New York and Pennsylvania accounting for a large proportion of all expenditures. Their use by southern states has increased, but is still not great.

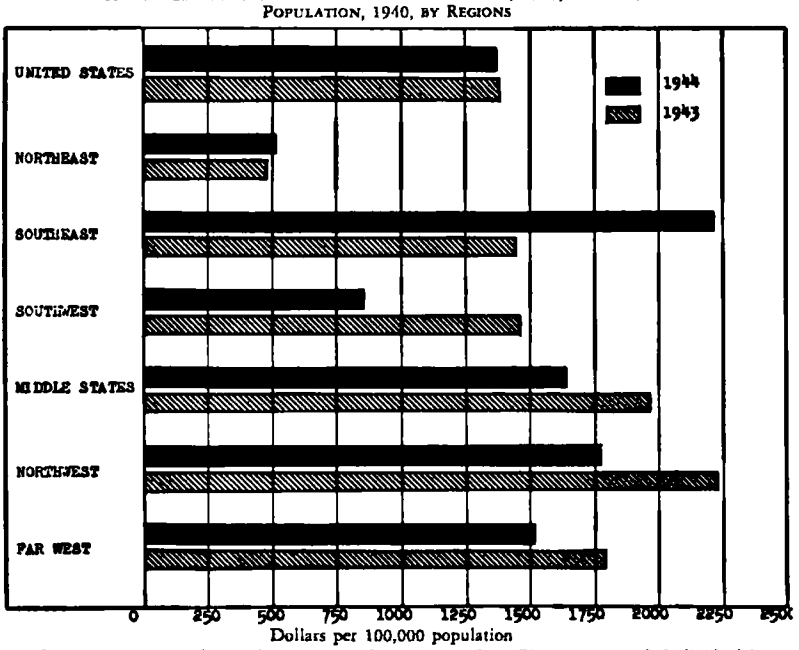
A listing by the National Resources Committee of state legislative studies in the electoral, legislative, judicial, and administrative fields between 1877 and 1937 shows that eight southeastern and all four southwestern states had studies made in the administrative field; five southeastern and no southwestern states in the judicial; one southeastern and no southwestern state in the electoral; and no state from either region in the legislative. These southern studies are a little less than one-fourth of the total number made in all states over the sixty-year period.

Geological Surveys

The one department with research as its chief function which is found in most state governments is the State Geological Survey. Expenditures for surveys can therefore be used to compare the different regions with regard to state government support of research. In recent years the Southeast has been spending more money for geological surveys than other regions. In 1944 its expenditures were 35 percent of the total reported to the Bureau of the Census. The Southeast also leads other regions in the amount spent for geological surveys in relation to population (Figure 32). The Southwest reported smaller expenditures than any other region but is above the Northeast in amount per 100,000 population. The expenditures vary from year to year but there is relative consistency, in that a state which ranks high tends to do so over a period of time. The amounts spent by the states range from nothing to more than $300,000 annually. Illinois and Louisiana spend far more for geological surveys than do the other states; in 1944

these two states accounted for more than one-third of the total. When the states are ranked according to expenditures in 1944, all the southeastern states come in the higher half, and it might be noted that Mississippi marches along with Massachusetts.

Figure 32. State Expenditures for Geological Surveys, 1944, and Approximate Total Available Funds of State Geological Surveys, 1943, per 100,000 Population, 1940, by Regions



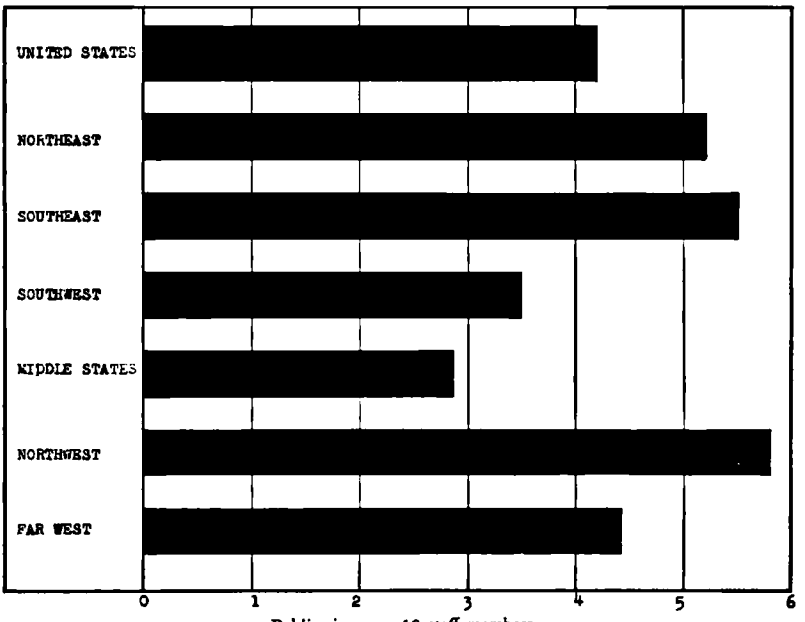
Source: State expenditures from Bureau of the Census, *State Finances: 1944, I, Individual State Reports*. Available funds from a compilation by Wilson M. Land, Association of American State Geologists. Population from *Statistical Abstract of the United States, 1941*, Table 12, p. 10.

A different compilation of data relating to state geological surveys is made annually by the Association of American State Geologists. This tabulation gives allotments for different types of projects and approximate available funds. In general the two sets of figures agree fairly well, but the January, 1944 compilation shows a much smaller figure for available funds in Louisiana than the expenditures reported in the *State Finances* series of the Bureau of the Census. This brings the Southeast below the Middle States in total amount of available funds. Smaller variations in the amounts for other states put North Carolina and Kentucky in the

lower half of the ranked states in this respect, and bring the Southeast below all other regions except the Northeast in available funds per 100,000 population. However, the amount is still slightly above the national figure because of the poor showing of the Northeast. The Southwest moves to a point slightly above the Southeast but remains below the Middle States, the Northwest, and the Far West (Figure 32).

Further data on technical personnel and technical publications in the Association compilations show the Southeast second among the regions in number of publications for each 10 technical staff members (Figure 33). The Southwest is next to the last position in number of publications as related to technical personnel. It seems clear that the Southeast compares more favorably with other regions in State Geological Survey activities than it does in most areas in research.

Figure 33. Technical Publications per Ten Technical Staff Members of State Geological Surveys, 1943, by Regions

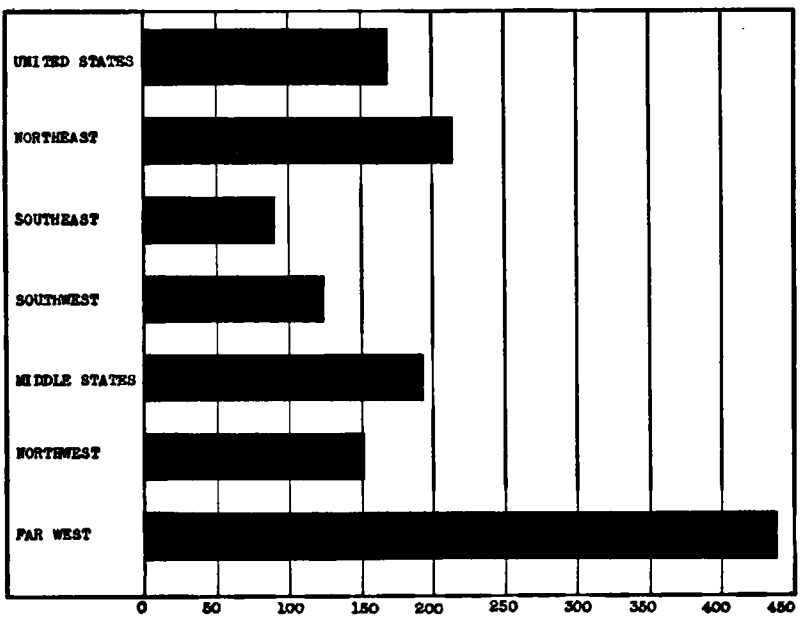


Source: Compilation by Wilson M. Land, Association of American State Geologists.

Agricultural Experiment Stations

The activities of the state agricultural experiment stations have been described in the preceding account of college and university research. In addition to their federal grants, these stations receive state appropriations. Indeed, some of the federal grants must be matched by state funds. These state appropriations for agricultural research are the state government funds most clearly designated for research. When 1942-43 appropriations are related to size of rural population, the southern states lag behind all others, as can be seen in Figure 34. It should be noted that appropriations have been increased by some of the southern state legislatures since these figures were compiled by the Office of Experiment Stations.

Figure 34. State Grants to Agricultural Experiment Stations, 1942-1943, per 1,000,000 Rural Population, 1940, by Regions



Source: State grants from Office of Experiment Stations, United States Department of Agriculture, *Report on the Agricultural Experiment Stations, 1943*, Table 2, p. 100. Population from *Sixteenth Census of the United States, 1940*, I, Table 7, p. 19.

State Planning Boards

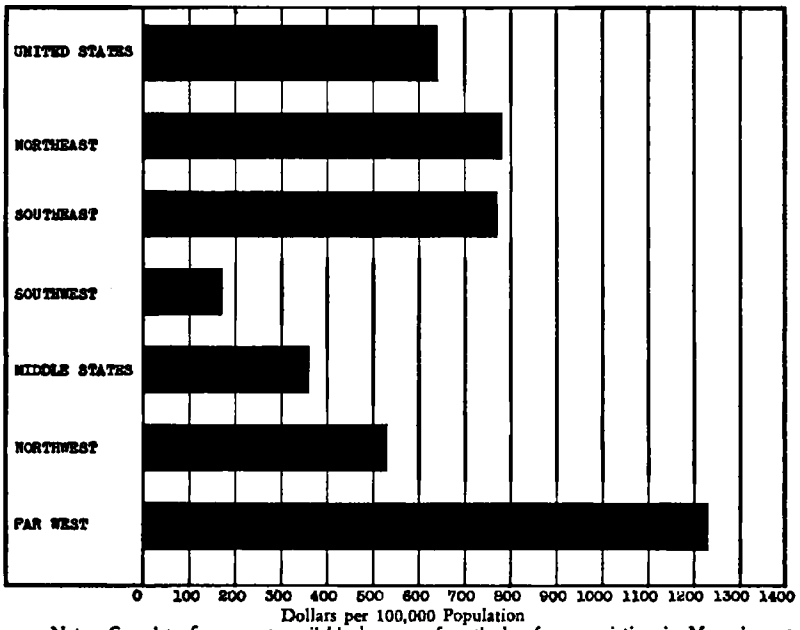
Another state government agency which usually devotes a considerable proportion of its efforts to research is the state planning board. State planning boards are relatively recent in origin, and their activities and status in the structure of the state government have not solidified into a definite pattern. Since 1933 they have been established in almost all of the states, but in some cases their existence has been intermittent. In June 1942 there were 42 working with the National Resources Planning Board through its regional offices and consultants.

Until its demise the National Board published summary reports of the activities of the state boards. In the earlier years most of the planning boards were concerned primarily with "making an inventory of the State's resources and the major problems concerning their use." Plans for the development and conservation of resources could not be made until complete information about the resources was in hand. As this work progressed it became clear that planning for physical resource development required consideration of broad social and economic needs, and consequent study in this field. The range of the investigations undertaken has, therefore, been extensive. The National Board has summarized the greater number under the headings of land studies, water studies, minerals, population, public finance, and other resources.

In later years more attention has been given to planning as distinguished from research, with wartime and postwar needs receiving major attention. Nevertheless, the constant need for research has continued and it still constitutes a large part of the work of some of the boards, particularly in states where the regular departments are not large enough or well enough financed to conduct needed research in their fields, a situation which prevails in most southern states. In these cases the planning board may serve as a general research agency for the state government, making for the Governor and for other departments whatever studies and investigations are needed in addition to those directly related to other planning board activities. A research staff is usually regarded as an essential part of the organization of a state planning board, whatever the range of its other work. As a research agency the planning board is also a source to which the

federal government and private individuals and groups can turn for information and for assistance in collecting information. The state boards have participated in a number of nation-wide studies, such as an inventory of public works, and the recreation survey of the National Park Service. Several state boards in the South assumed the responsibility of securing the necessary data upon which initial rural public housing programs were launched through the United States Housing Authority.

Figure 35. STATE PLANNING BOARD APPROPRIATIONS VOTED BY STATE LEGISLATURES, 1942, PER 100,000 POPULATION, 1940, BY REGIONS



Note: Complete figures not available because of methods of appropriation in Massachusetts and Louisiana. The additional sums would make the totals for the Northeast and the Southeast slightly larger.

Source: National Resources Planning Board, *State Planning*, June, 1942, Introduction, p. vii.

With the varying emphases of planning boards in the different states, and at different periods in the same state, comparisons can be used only as rough indicators of state government provision for research. In the Northeast, the Southeast, and the Far West the appropriations for state planning were greater in 1942 than in 1938; in the Southwest, the Middle States, and the Northwest they

were less. Figure 35 shows that the Far West spent more per capita for state planning than any other region in 1942. The Southeast and the Northeast were next and close together; in both these regions the figures given by the National Resources Planning Board were less than the actual amount expended because of peculiarities in the appropriation procedures of Massachusetts and Louisiana. In 1942 there were state appropriations for planning boards in all southeastern states except Kentucky and North Carolina. In the Southwest, New Mexico and Oklahoma made appropriations, Arizona and Texas did not. The North Carolina Board was reactivated late in 1943, but was again discontinued on June 30, 1947.

The southern planning boards, like many others, have given their major attention in recent years to economic fields, with emphasis on employment opportunities and industrial development. The Alabama, Georgia, and South Carolina Boards have studied natural resources as materials for new industries, and the American Society of Planning Officials considers the industrial research of the Tennessee Board to be especially good. The South Carolina Board, since incorporated into a new Department of Research, Planning and Development, published an outstanding series of bulletins on its industrial studies. In Louisiana the State Committee for Economic Development functioned for a while as a state planning board, working with state departments and local groups. Later it was incorporated into the Louisiana Department of Commerce and Industry, where the major emphasis of study and planning is industrial development. In Virginia an extensive population study was started during the war under the auspices of the State Planning Board, with financial support from the General Education Board. This study is continuing at the University of Virginia. The North Carolina State Planning Board, especially during 1945 and 1946, conducted research studies including an inquiry into the migration out of the State of technically trained college graduates, a study of new industrial opportunities in North Carolina, experimental research in industrial uses of the whole cotton plant, and an exhaustive analysis of the needs of and services for children and youth in the State.

These instances indicate the wide variety to be found among the state planning agencies of the South. Their status and financial support remain uncertain in most states, in spite of the excellent

work which has been done in a number of cases. The reorganization in South Carolina presents one instance of acceptance of the research and planning functions as necessary parts of the organization of state government.

Other State Departments

In other departments and agencies in state governments, activities merge into research at some points. Data, such as vital statistics, are collected; these then become available for further analysis. Specific experiments may be conducted, such as those made by highway departments on road building materials and methods. In relatively few instances do these research and research-related activities constitute any large proportion of the work done by the departments. There has been a tendency in recent years to give formal recognition to research functions through the establishment of bureaus of research and statistics within departments, but for the most part the work of such bureaus is limited to the collection and publication of statistical data, with occasional analyses and interpretations. There are a few exceptions exemplified by a permanent tax research bureau which makes detailed studies of problems relevant to the taxing function of the state.

A fairly large proportion of the occasional research activities of state government agencies consists of cooperative participation in surveys and investigations initiated by federal agencies or private organizations. Forestry and conservation departments have contributed to surveys of forest resources by the National Forest Service and the American Forestry Association, and similar assistance has been given to surveys of wildlife resources by the state departments concerned. Health departments make special studies in cooperation with the United States Public Health Service, and highway departments regularly cooperate with the Public Roads Administration in surveys of conditions and needs. Further examples of federal-state cooperation in research may be noted in the fields of welfare and education.

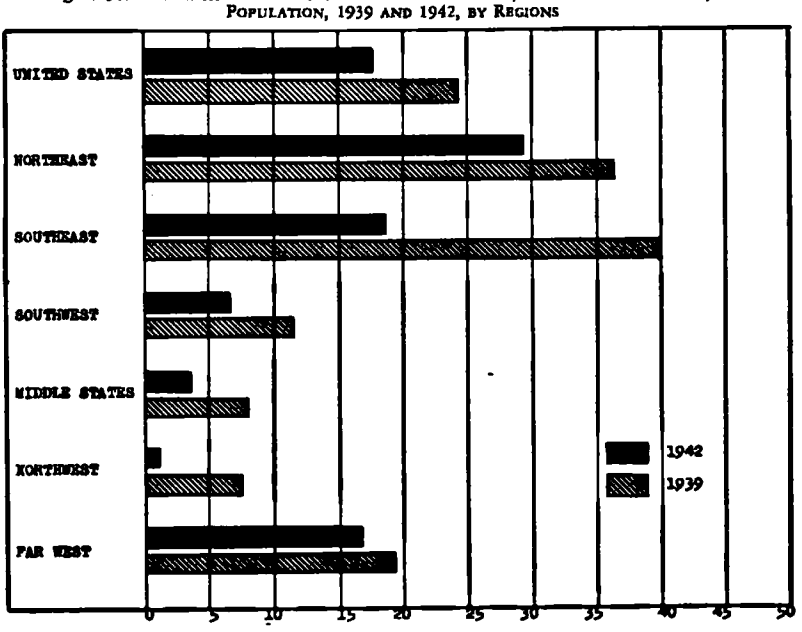
Research needs of state government agencies are also met through arrangements with university faculty members and departments. University research bureaus and institutes may provide survey and consultation services to state agencies, as in the

case of educational research bureaus and state departments of education.

MUNICIPAL EXPENDITURES FOR RESEARCH

In 1939 there were 13 southeastern cities with populations of 100,000 or more, and 10 reported expenditures for research. This proportion was higher than that of any other region. In 1942 the Far West showed more widespread use of research, with all 10 of its cities of this size reporting research expenditures. The Southeast came next with 11 out of 14 cities, and the Southwest third with 4 out of 6. The Southeast led other regions in expenditures per 1,000 population in 1939, but dropped behind the Northeast on this measure in 1942 (Figure 36).

Figure 36. Research Expenditures of Cities Over 100,000 Population per 1,000 Population, 1939 and 1942, by Regions



Source: Bureau of the Census. *Financial Statistics of Cities Over 100,000 Population 1939*, Table 15, pp. 124-126 and *City Finances, 1942*, Table 17, pp. 40-42.

Privately supported bureaus of municipal research have functioned effectively in a number of the larger cities of the country

since the first one was established in New York in 1906. They have given valuable assistance to city governments and have demonstrated the value of research to good government. As non-partisan and unofficial agencies representing the citizenry at large, their objective has been the improvement of government through study of governmental problems and the presentation of facts on these problems to the public. As a rule, close relations are maintained with city departments, and frequently the results of investigations are used directly by the departments. Because of this relationship their work is described along with city government research.

A study of these private bureaus by Norman N. Gill, made for the Committee on Public Administration of the Social Science Research Council and published by the American Council on Public Affairs, presents data for 20 agencies, the principal ones which can properly be called "independent municipal research bureaus." Most of the 20 are in New England and the Middle States. Only one is in the South, the Bureau of Governmental Research of New Orleans. This bureau is supported by dues from approximately 400 members and by special contributions and is governed by an elected Board of Directors. There are usually four regular staff members. The stated aim of the Bureau is "to secure improvement in city and state government by collecting, analyzing, and presenting facts necessary to improve administration." Some Bureau reports are submitted privately to the officials concerned and not given publicity unless it seems needed. Others are presented to help citizens understand their government. A regular bulletin, *City Problems*, is issued. A sampling of subjects treated in recent years shows the variety of studies undertaken: the relation of teachers' salaries to school improvement, the pension problem of New Orleans, public employment figures (to keep the electorate informed of possible pay roll padding during an election), trends in general fund expenditures, recommended establishment of a central school personnel division, voting machines, constitutional amendments, and two outstanding series on population problems and public relief problems. A Bureau Library is maintained and coordinated with the union library catalog in New Orleans.

Other private organizations, such as taxpayers' leagues, research divisions of chambers of commerce, and civic organizations conduct investigations relevant to city government operations and

problems. These have been chiefly in the fields of finance and taxation and the quality of the work is highly variable. State leagues of municipalities and professional organizations of public officials have also provided limited research service to local governmental units. Information on special topics may be secured from the leagues or, through them, from national organizations in this field.

THE SOUTH LESS BACKWARD IN GOVERNMENTAL RESEARCH

The South is clearly not so far behind the rest of the country in governmental research as it is in university and industrial research. Besides sharing in Federal Government research, its state and city governments support research about as well as those in other parts of the nation. The legislators and public officials of the southern regions seem aware of the help which research can give and are attempting to use it. Local governmental research is a more recent development everywhere than industrial and university research; perhaps the South is now ready to participate fully in national movements. The failure of the South to develop industrial and university research is at least partly a matter of its isolation from the rest of the country and its absorption in bare survival during the period when science was making its greatest advances in other regions. However, it should be noted that the relative position of the South is best where the smallest total amounts of money are involved. For instance, it leads in appropriations to state geological surveys, but it is behind in state appropriations to agricultural experiment stations.

The relative adequacy of the South in governmental research in no way lessens its need for the other kinds of research, since there is specialization among the different types of conducting agencies. However, governmental encouragement will help both university and industrial research, and the recognition by southern state and city governments of the value of research gives promise of encouragement for other agencies when and where it is needed.

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THE DEVELOPMENT AND USE OF RESEARCH RESOURCES — A CHALLENGE TO THE SOUTH

THE DEVELOPMENT AND USE OF RESEARCH RESOURCES—A CHALLENGE TO THE SOUTH

UNLIKE many natural resources, research resources can be increased in quantity and improved in quality. And, like all resources, they can be made to contribute more to human well-being through wise development and use. The South needs far more research than it now possesses. This need cannot be met merely by talking about it, or by isolated personal effort. Meeting it will not be an easy task and it cannot be accomplished overnight, but a beginning must be made if this region is to come to full participation on an equal basis in the national life. Postponement will only accentuate the problem by increasing present regional imbalances.

Where, then, does one begin? How can southern industry and southern government put science to work to raise the economic level of the region if workers trained in the use of science are not available and there is little public appreciation of what research can do? How can adequate training be provided with limited financial resources and little existing demand for technical personnel? How can a wide appreciation of the need for increased research and research training be built without demonstration of its practical value and the influence of research institutions and personnel in the region? The answer for the region is undoubtedly that one begins everywhere; for the individual or organization that one begins anywhere. Each advance promotes another, as surely as each failure to advance prevents the forward steps which might be built on it.

Southern industry and business can increase their appreciation of their own dependence upon the development of the region as a whole. They can learn to cooperate within their own group through trade associations and through supporting private research agencies to conduct and to promote scientific research which will be of benefit to all. They can recognize their stake in the education of youth and give general support and specific assistance to the improvement of training facilities. They can increase their

cooperative research with southern colleges and universities, thus adding to the total institutional resources and at the same time assisting in the guidance of university research into needed fields. They can give active demonstration in their organization and personnel practices that they will use and give recognition to scientific skill. They can use their influence, as individuals and through organizations, to promote a wider appreciation of scientific procedures as efficient means to attain desired ends, in other aspects of life as well as in money-making.

Southern colleges and universities can bend their efforts to improving their research training in the natural and the social sciences. They can devise techniques for recognizing and making more economical use of research talent in their faculties. They can raise their standards of instruction and research training through all possible means. They can give more attention to building cooperative relationships with industry and business and with government agencies in order that training may be directed toward needs and that the results of fundamental research may be made available and comprehensible to those who can give them practical application. They can work out cooperative plans among themselves to make the most of their slender resources by providing for all essentials and at the same avoiding unnecessary duplication.

Southern government agencies, executive and legislative, can continue and increase support of research in departments of state government and in state educational institutions. They can recognize more fully the contributions which scientific research, especially in the social sciences, can make to the broad questions with which public policy is concerned. They can promote scientific training in the natural and social sciences throughout the educational system. They can encourage private as well as public research, and promote cooperation among governmental agencies and between these agencies and private research interests.

The rest of the country will not wait for the South to catch up. Help from outside, whether the source be private or public, will keep the South in the status of a colonial region, dependent upon financial and intellectual philanthropy. Its development will be in the direction and at the pace set by decisions it does not make itself. If the southern people can achieve confidence in themselves

and their region based upon sound knowledge of resources and ways of using them, if they can develop a trained and inspired leadership to point the way to making the most of their resources and their capacities, if they can pull together for this common goal, then the South can regain its position of respect and worth in the nation, valued because it makes a worthy contribution to the whole.